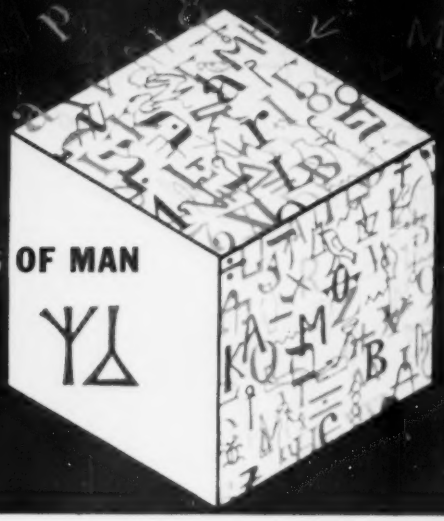
Aviation Week
and Space Technology

September 19, 1960

Special Report On IATA General Meeting

Avro 748 Turboprop

ANOTHER
ASPECT
OF THE
MARQUARDT
MISSION



INFORMATION STORAGE AND PROGRESS OF MAN

If the technological history of man's accomplishments were divided into a twenty-four hour day, the accomplishments of the twenty-fourth hour would vastly outweigh the sum total of the first twenty-three. This surge of progress has resulted in part from man's ability to permanently record and use information relating to his experience.

The writing of human experience — the first permanent information storage system — began only 10,000 years ago. The pages of history written since, would require a storage area larger than the Empire State Building to contain them. Thus man's ability to chronicle facts has far exceeded his capability to store them for easy reference.

Now scientists in the Pomona Division and ASTRO, Marquardt's division for research into the space age, are developing a multi-channel information storage system with an order of magnitude superior to any known storage method. RESULT: all information recorded during the first 100 centuries of civilization's history may be stored in a 6 foot cube.

The future, viewed in the perspective of this new memory potential, offers man the opportunity for an even greater rate of progress — wherein it is possible to envision the achievements of the last minute of the exemplary 24th hour exceeding the sum-total of the first 1,439 minutes.

New information storage concepts typify but one aspect of The Marquardt Mission.

Creative engineers and scientists are needed.

ASTRO DIVISION

THE Marquardt CORPORATION

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Fast and easy installation is an important advantage of these "packaged" hydraulic power and control systems by Vickers. It saves time at the missile site — keeps "on-the-spot" labor charges low. That's important! Yet this fast installation is only one of the benefits you get with these factory-built power packages.

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Reduce Field Inventory — As far as possible, units are designed with components that are commercial "shelf" items. Inventories of warehouse stocks can be kept low because of component and part interchangeability.

How far advanced is your project? If it is in the design and development stage, we can *immediately* place a team of hydraulic specialists in your plant to work with your engineers. If it is in the "breadboard" stage, let us give you an alternate proposal. On many applications we have suggested much improved power units at attractive production-line prices.

Write for Bulletin 5303
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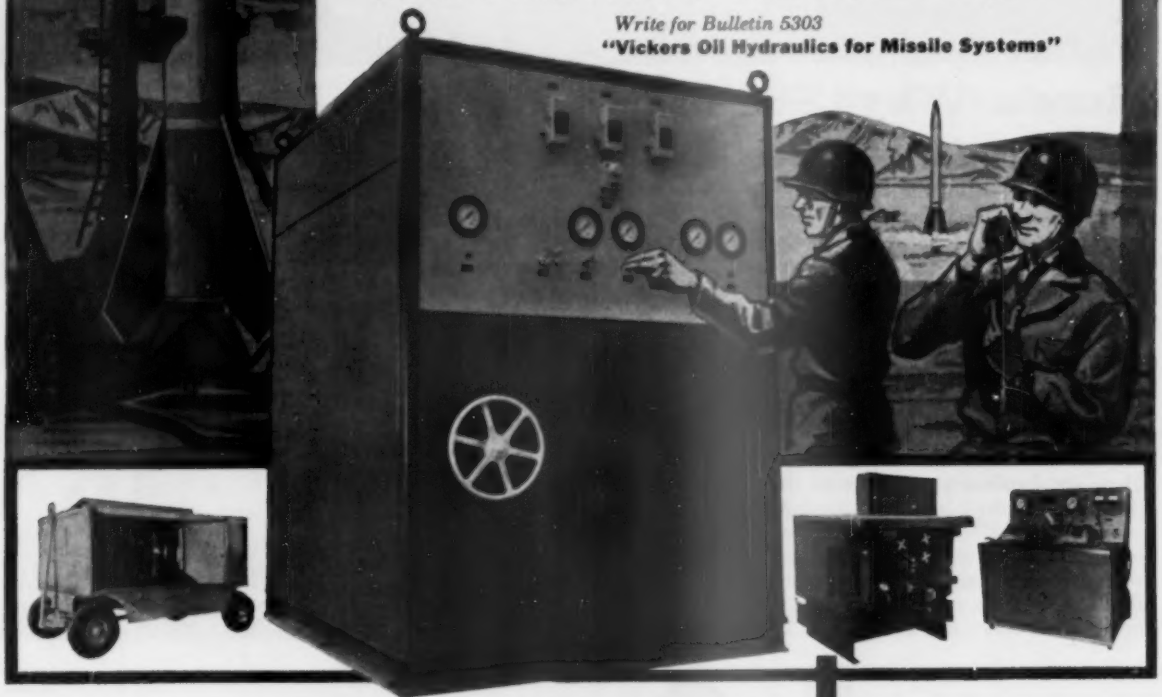

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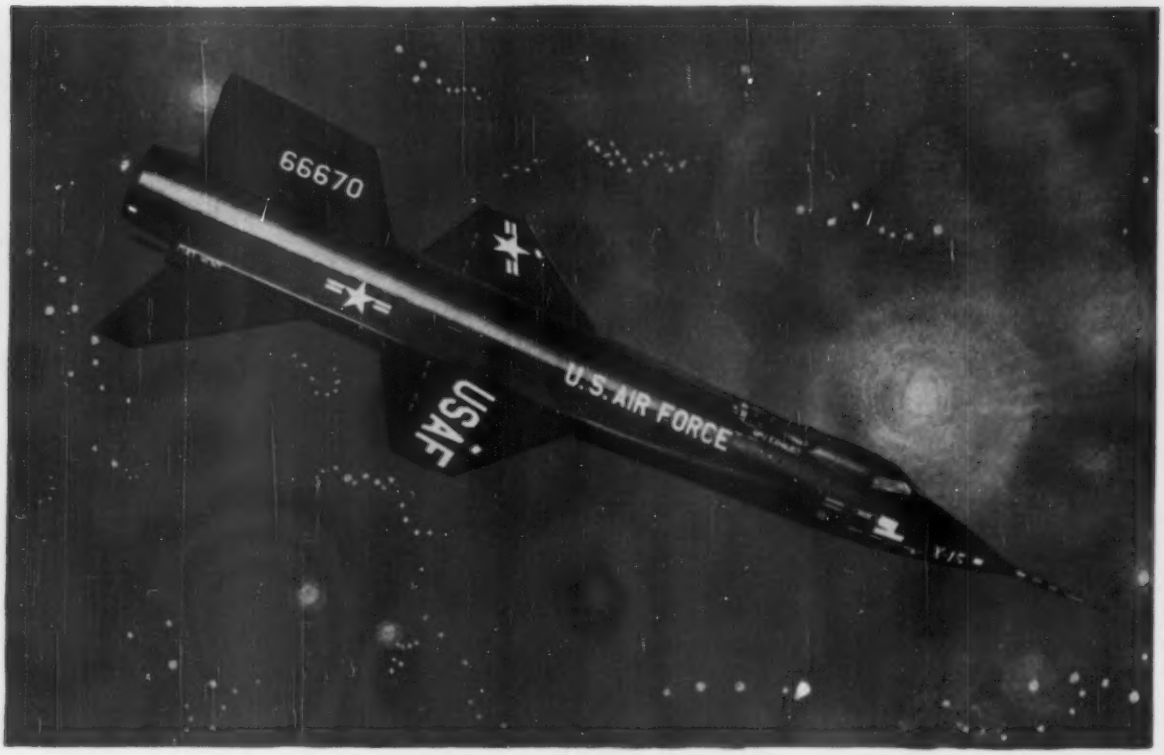
SILICONE NEWS from Dow Corning

Beyond All Others...



Here's Why Silastic Is Used In Man's Probes Into Space!

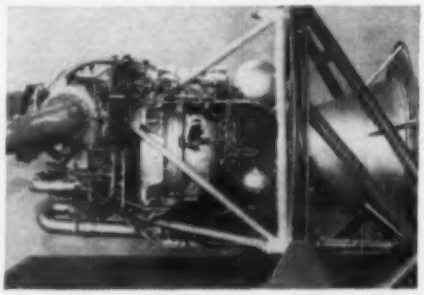
By going faster and farther into space, the X-15 adds to our rapidly expanding knowledge about the chances of men and materials surviving the trip out—*and back*. That's why only proven materials are selected. One of those is Silastic® LS, the Dow Corning fluorosilicone rubber that resists oils, fuels and solvents.

Engineers of Reaction Motors Division of Thiokol Chemical Corporation specified an accumulator diaphragm of Silastic LS for the X-15's XLR-99 engine. The accumulator provides oil at a constant pressure to the lube oil pump. Gaseous nitrogen under pressure is the source of stored energy, and is separated from 4-11V Halocarbon oil by the Silastic LS.

Here are diaphragm requirements the designers established as essential: An elastomer flexible from —80 to 200 F (Silastic LS maintains its flexibility from —80 to 500 F); compatible with the lube oil at low and elevated temperatures (Silastic LS has little swell or change in durometer readings after immersion in many hot oils, fuels and some hydraulic fluids); will not contaminate lube oil (Silastic LS has no plasticizers or additives which can contaminate by leaching).

Silastic LS... the only elastomer to meet all these requirements... helps the X-15 as it knocks on the door to outer space.

Shown below is the XLR-99 rocket engine. The lube oil accumulator is the light weight type... made possible by the diaphragm of Silastic LS... instead of the heavy, bulky piston type. Parts of Silastic can be engineered to meet your specific needs by your rubber fabricator.



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AVIATION CALENDAR

Sept. 27-30—Space Power Systems Conference, American Rocket Society, Miramar Hotel, Santa Monica, Calif.

Sept. 28-30—Conference on Solid State Nuclear Particle Detectors, Asheville, N. C. Sponsors: Air Force Office of Scientific Research; National Academy of Sciences.

Oct. 1—Second Annual Fly-In for General Aviation, National Aviation Facilities Experimental Center, Atlantic City, N. J. Sponsor: Federal Aviation Agency's Bureau of Research and Development.

Oct. 2-10—Federation Aeronautique Internationale Annual Meeting, Barcelona, Spain.

Oct. 3-5—Sixth National Communications Symposium, IRE, Utica, N. Y.

Oct. 3-5—Seventh Annual Meeting, Institute of Radio Engineers' Professional Group on Nuclear Science, Gatlinburg, Tenn. Cosponsor: Oak Ridge National Laboratory.

Oct. 3-5—National Midwestern Conference on Air Logistics, Institute of the Aeronautical Sciences, Tulsa, Okla.

Oct. 3-5—First International Air Traffic Control Conference and Fifth Annual Meeting of the Air Traffic Control Assn., Sheraton-Palace Hotel, San Francisco.

Oct. 4—13th Annual New York State Aviation Development and Operation Conference, Hotel Onondaga, Syracuse, N. Y.

Oct. 4-6—Sixth Conference on Radio Interference Reduction, Chicago, Ill. Sponsors: Armour Research Foundation; U. S. Army; U. S. Navy; USAF; IRE.

Oct. 5-7—Briefing Session on Opportunities in Space-Age Technology, American Management Assn., Hotel Astor, New York, N. Y.

Oct. 6-8—Annual Convention, Airmail Pioneers, El Cortez Hotel, San Diego, Calif.

(Continued on page 6)

AVIATION WEEK and Space Technology

September 19, 1960

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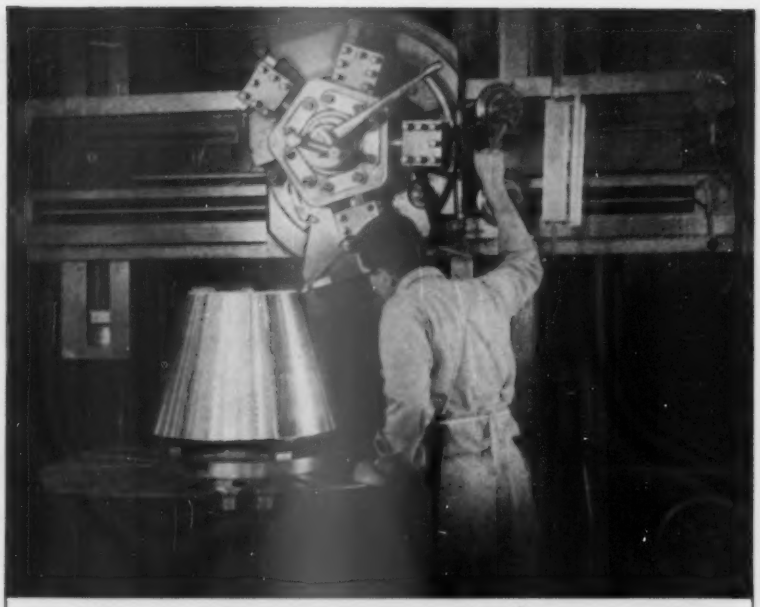

missile / AEROSPACE COMPONENTS BY LAVELLE

Sheet metal wall thickness is controlled as the outer surface of an aluminum alloy nose cone is machined to precision size on a boring mill at Lavelle. Part of the RVX Series re-entry vehicle structure, recovered after full ICBM range flight, the machined cone is typical of methods used by Lavelle to meet the varied requirements of the aerospace industry.

Shown between the nose cone structures above is a part of the Hawk missile system, a radar pedestal base magnesium weldment partially machined after assembly. Lavelle works with a wide range of metals and alloys to produce sheet metal components for missiles, electronic systems and ground support equipment to exacting specifications. Major companies rely on Lavelle for precision components required in missiles, space vehicles, jet engines and airframes.

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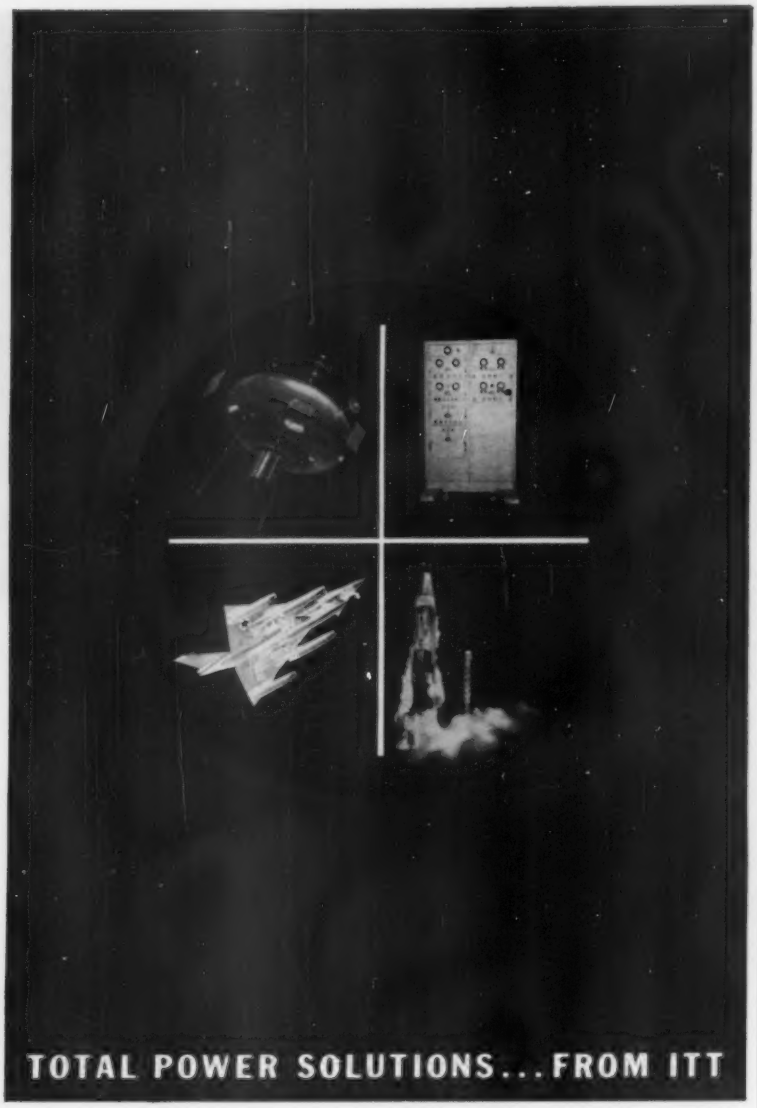

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AVIATION CALENDAR

(*Continued from page 5*)

Oct. 6-8—Society of Experimental Test Pilots Symposium on "Omni-sonic Flight," Ambassador Hotel, Los Angeles, Calif. Fourth Annual Awards Banquet, Oct. 8.

Oct. 6-9—Annual Meeting, National Pilots Assn., Western Hills Lodge, Wagoner, Okla.

Oct. 8—Third Annual National Aero Club Football Fly-In, Michigan vs. Duke, Ann Arbor, Mich.

Oct. 10-12—1960 National Electronics Conference and Exhibition, Hotel Sherman, Chicago, Ill.

Oct. 10-14—Society of Automotive Engineers National Aeronautic Meeting, Ambassador Hotel, Los Angeles, Calif.

Oct. 12-14—Third AFOSR Astronautics Symposium, Ambassador Hotel, Los Angeles, Calif. Sponsors: Air Force Office of Scientific Research; Society of Automotive Engineers. (Open Meeting.)

Oct. 12-14—Seventh National Symposium, American Vacuum Society, Cleveland-Sheraton Hotel, Cleveland, Ohio.

Oct. 14-15—Symposium on High-Speed Processing, Society of Photographic Scientists & Engineers, Washington, D. C.

Oct. 14-15—15th Midwest Conference, American Society for Quality Control, Broadview Hotel, Wichita, Kan.

Oct. 16-19—Mid-Year Conference, Airport Operators Council, San Francisco, Calif.

Oct. 17-18—Joint Meeting, Institute of the Aeronautical Sciences and Canadian Aeronautical Institute, Queen Elizabeth Hotel, Montreal, Canada.

Oct. 17-21—National Safety Council's 48th National Safety Congress, Conrad Hilton Hotel, Chicago, Ill.

Oct. 19-21—Annual Convention, Southeastern Airport Managers' Assn., Far Horizons Motel, Sarasota-Bradenton, Fla.

Oct. 19-21—Symposium on Space Navigation, Institute of Radio Engineers, Deshler-Hilton Hotel, Columbus, Ohio.

Oct. 19-21—Annual Meeting, Society for Experimental Stress Analysis, Hotel Claremont, Berkeley, Calif.

Oct. 20-21—National Symposium on Hypervelocity Techniques, Institute of the Aeronautical Sciences, Shirley-Savoy Hotel, Denver, Colo.

Oct. 24-26—Medical and Biological Aspects of the Energies of Space, Unclassified Symposium, Granada Hotel, San Antonio, Tex. Sponsored by the School of Aviation Medicine. Arranged by Southwest Research Institute.

Oct. 24-26—Seventh East Coast Conference on Aeronautical and Navigational Electronics, Institute of Radio Engineers, Lord Baltimore Hotel, Baltimore, Md.

Oct. 25-27—11th National Conference on Standards, Sheraton-Atlantic Hotel, N.Y.C.

Oct. 27-28—1960 Annual Electron Devices Meeting, Institute of Radio Engineers, Hotel Shoreham, Washington, D. C.

Oct. 27-29—1960 Industry Display, Aircraft Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif.

Nov. 2-4—Tenth Aircraft Hydraulics Conference, Pick-Fort Shelby Hotel, Detroit, Mich., Sponsor: Vickers, Inc., division of Sperry Rand Corp. (Invitational.)

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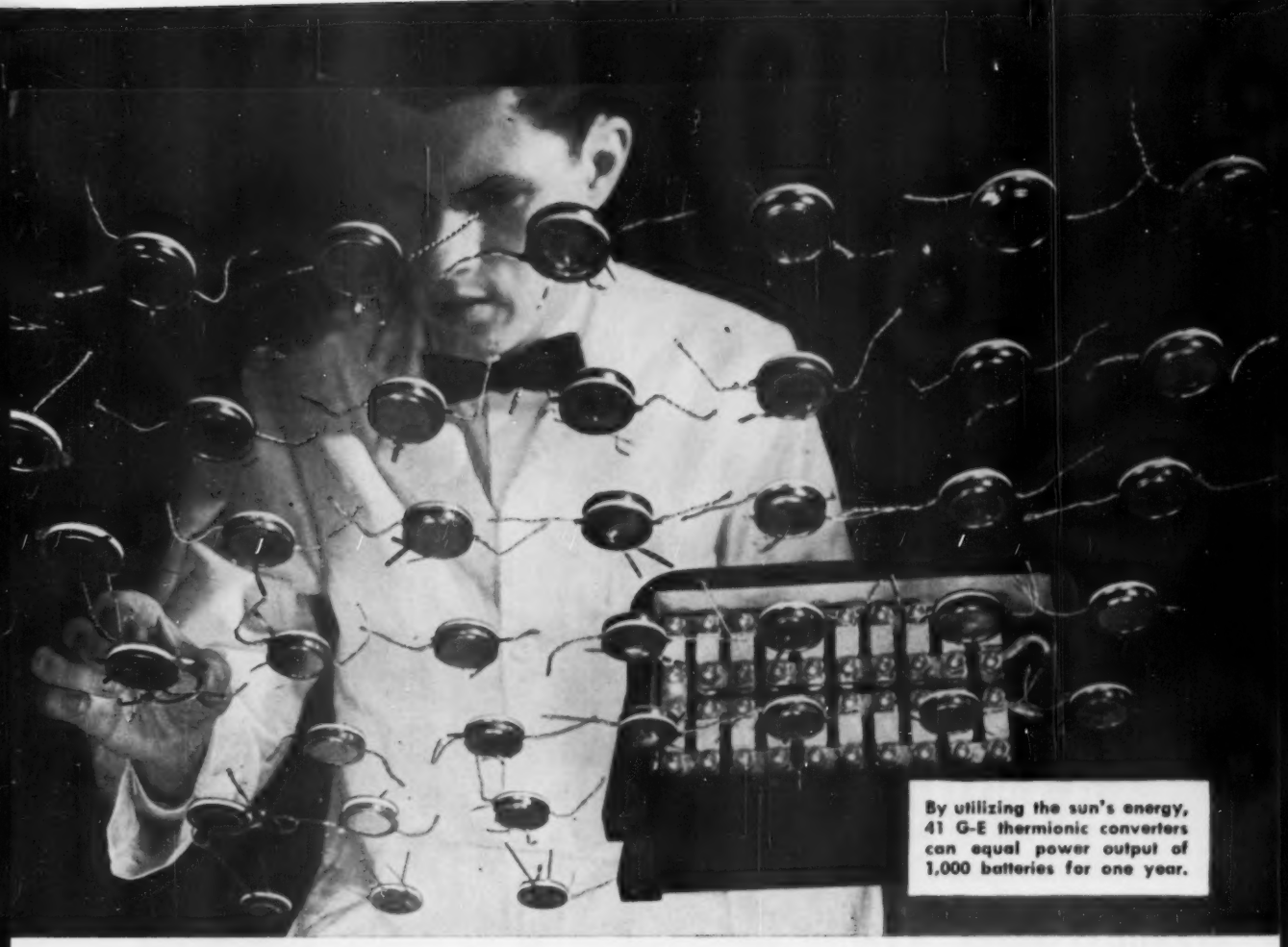

By utilizing the sun's energy, 41 G-E thermionic converters can equal power output of 1,000 batteries for one year.

MISSILE AND SPACE VEHICLE DEPARTMENT

...center for missile and space technology research and development at General Electric

Progress in power for space

Manned space flights, as well as other U.S. space projects, will require new, light-weight, long-life sources of electrical energy. Conventional batteries, now being used in missiles and satellites, are far too heavy for most future space applications.

For example, during a year's operation, one thousand 15 amp/hr batteries, similar to the one shown above, would be required to equal the 41 watts which the thermionic converters in the photo can generate from the heat of the sun. These batteries would weigh 15,000 lbs—a complete thermionic system, including the converters developed in General Electric's Research Laboratory plus a collector and orientation equipment, only about 20 lbs.

To provide such new, light-weight systems, engineers at General Electric's Missile and Space Vehicle Department are investigating a wide variety of promising space power sources, utilizing the specialized capabilities of other Company research operations. For instance, under U.S. Air Force contract, G.E. is conducting extensive research in thermionics, and is developing an experimental thermionic system consisting of a solar collector, converters, and storage and control components. Intensive work in photovoltaics includes the development of an advanced unit to provide more than 500 watts of continuous power for the Advent communications satellite.

For the U.S. Army Signal Research and Development Laboratory, a regenerative fuel cell is under development, as are magnetohydrodynamic electrical converters for the Air Force Office of Scientific Research, WADD and BMD. In addition, MSVD is investigating nuclear thermionics and nuclear turbines.

To learn more about these MSVD space power developments, write to Section 160-76, General Electric Co., Missile and Space Vehicle Department, Philadelphia 1, Penna. 160-76

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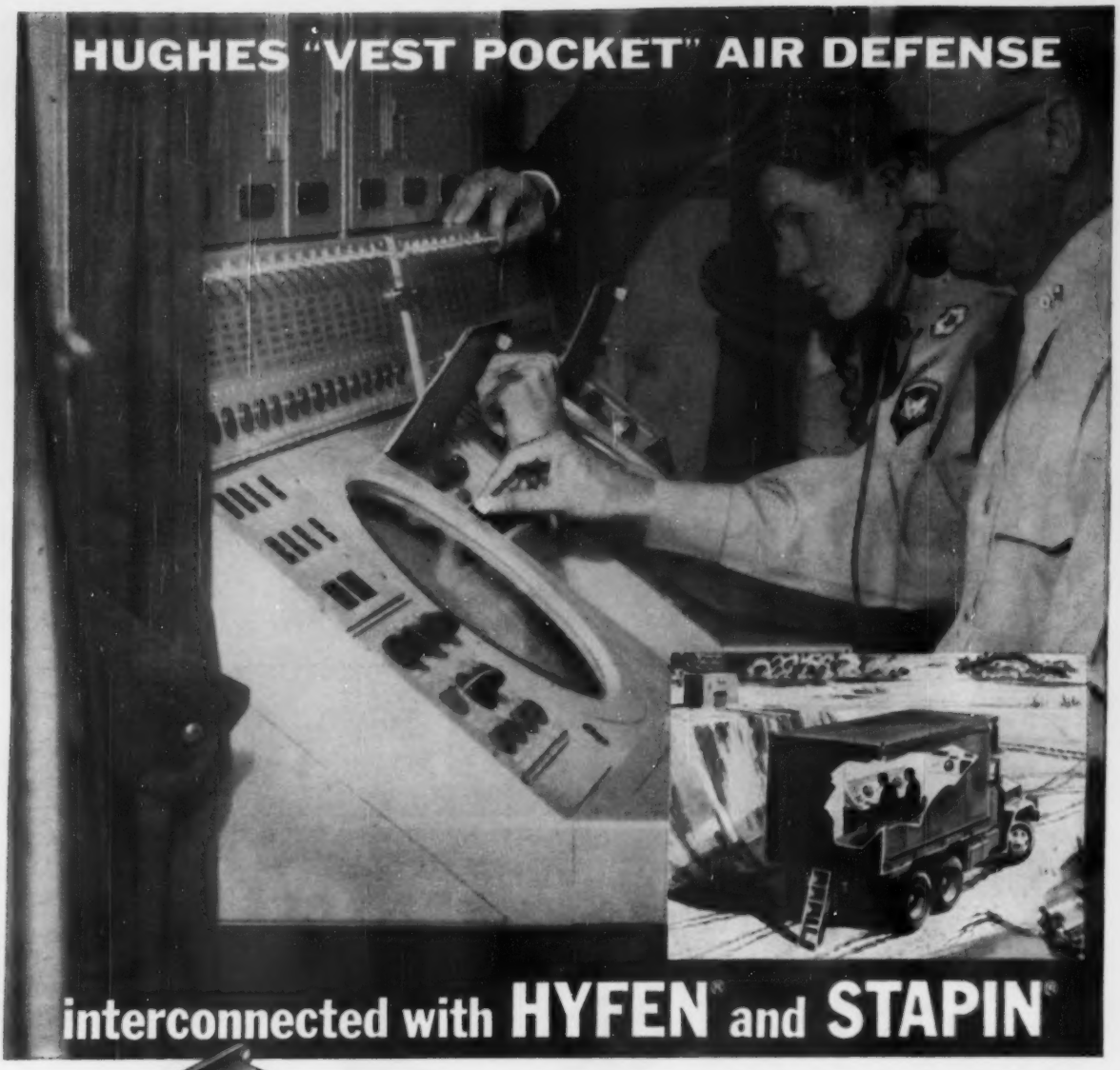

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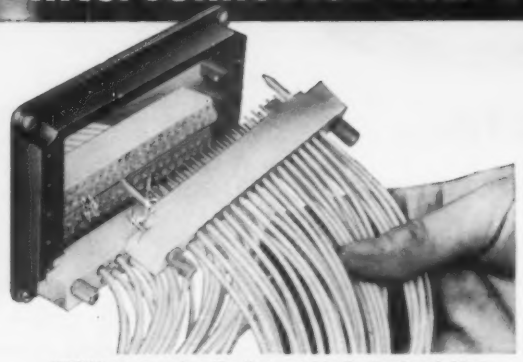

HYFEN-type connectors like those used in the "vest pocket" air defense system have pins and sockets tool-crimped on cable ends, snap-locked in inserts with wide range of configurations. HYFEN and STAPIN inserts are mounted in panels as required.

A highly mobile electronic air defense system insuring nearly instant destruction of hostile aircraft by coordinating antiaircraft missile firing at split-second speeds has modernized the field army's air defense capabilities. This "vest pocket" air defense, mounted in standard, heavy duty 2½-ton Army trucks, is another high-quality development of one of America's leading manufacturers of military electronic systems, the Hughes Aircraft Company.

This air defense system's complex circuits are interconnected with Burndy HYFEN and coax STAPIN connectors. Contacts are tool-crimped on wire ends at the workbench, then snap-locked into inserts on the job, reducing time and skill required to install and service, assuring dependable connections of measurable quality.

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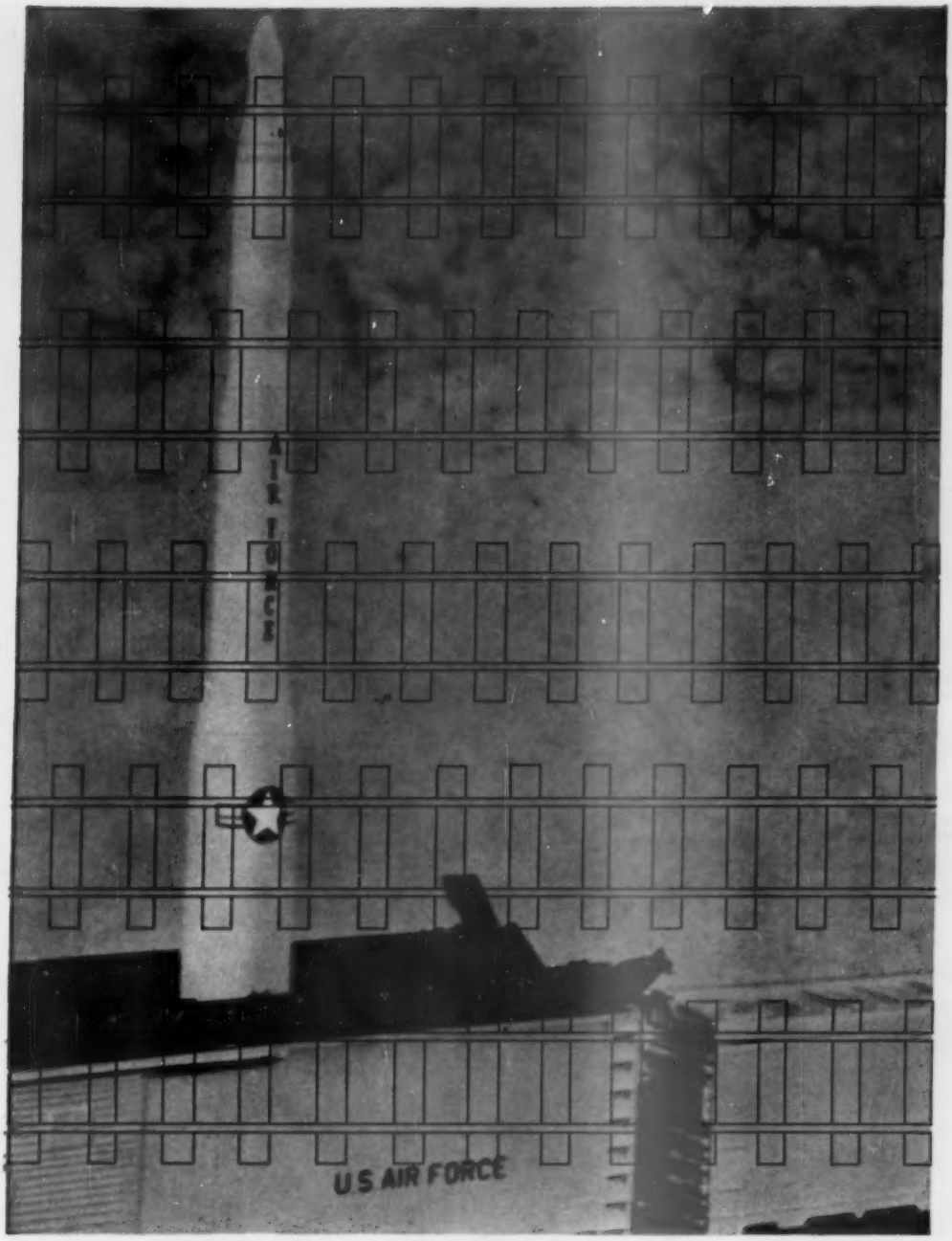

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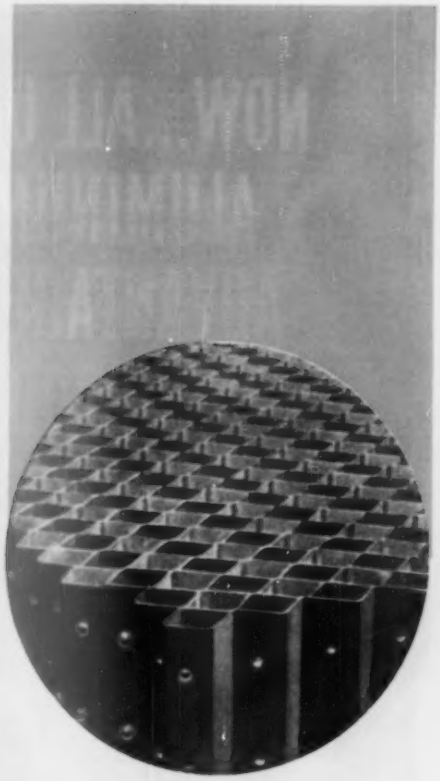
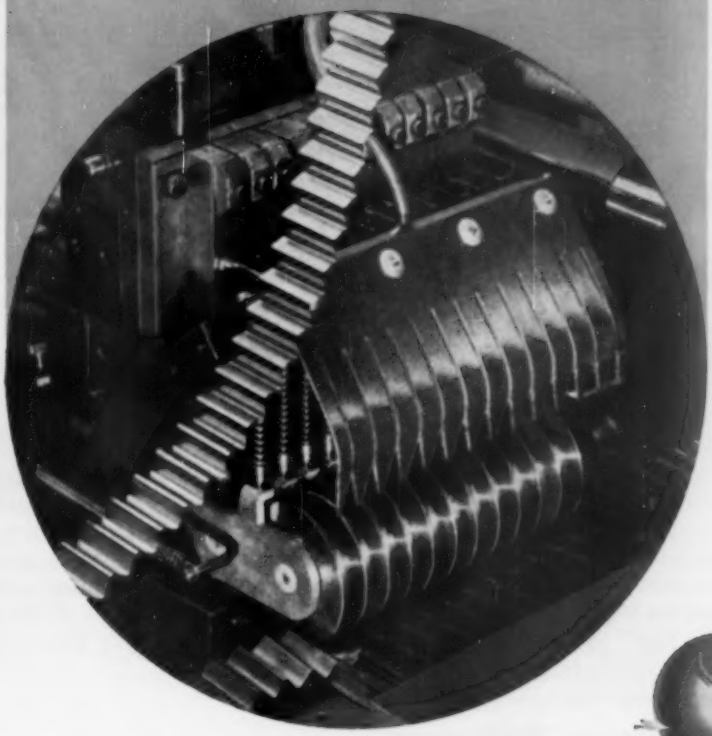
GETTING TO THE CORE OF HONEYCOMB COSTS





Lower cost stainless steel honeycomb is in prospect, thanks to a new Rohr machine. Automatically, and many times faster than past methods, this remarkable machine fabricates and welds a number of integrated core structures simultaneously. Quality is higher, and there is virtually no limit to the size of panels its continuous operation can produce. These Rohr-designed, Rohr-built machines are in operation now. They typify Rohr's ability to come up with the machines and techniques that solve manufacturing problems. For twenty years, Rohr has been contributing this kind of down to earth engineering and production know-how to American industry. Perhaps we can put it to work for you.

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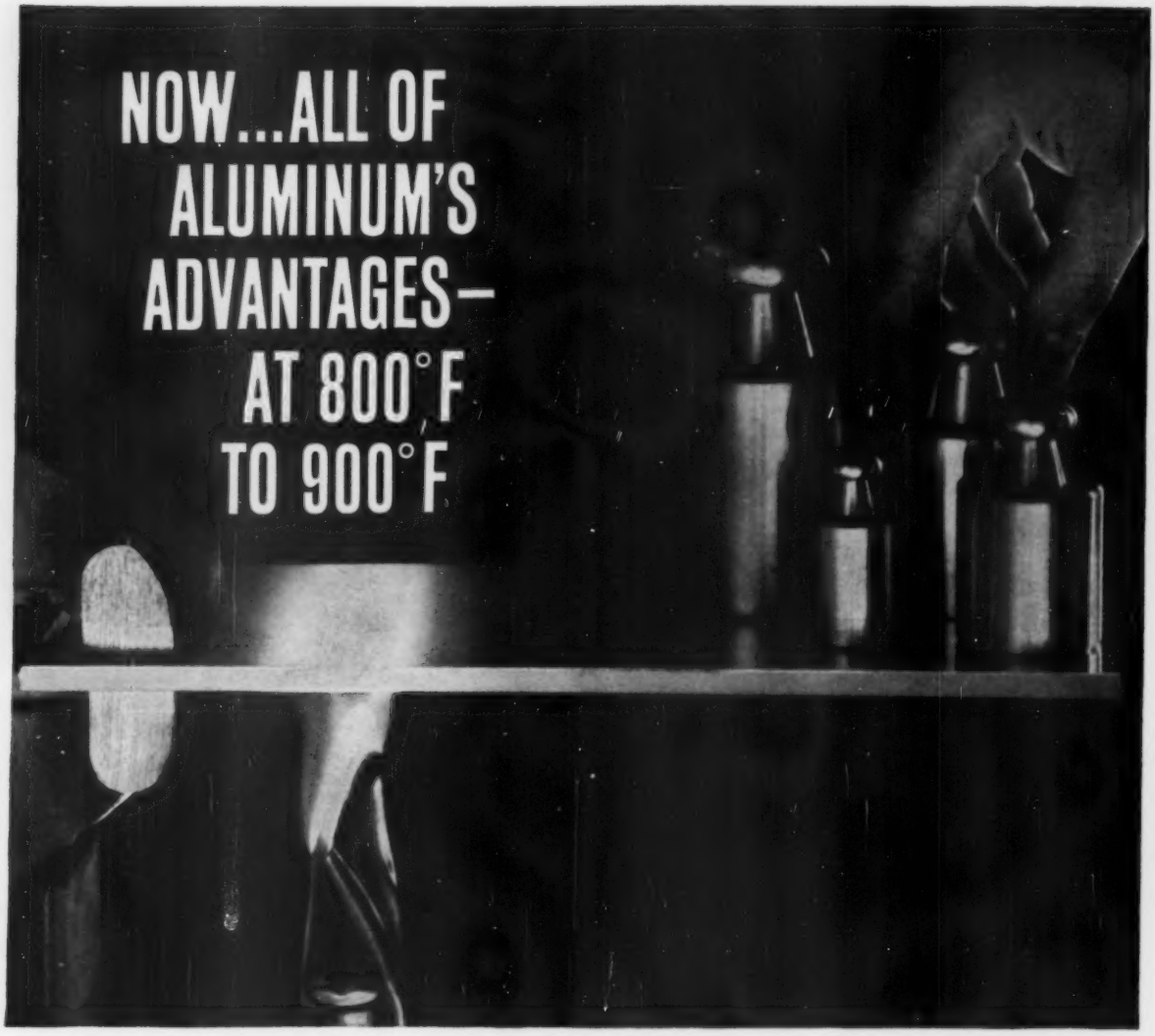

New Powder Metallurgy Products Broaden Aluminum's Defense Applications

THE TRADITIONAL advantages of aluminum—at temperatures up to around 500°F—can now be extended to temperatures hundreds of degrees higher than conventional aluminum can take.

THANKS TO Alcoa's pioneering with the metallurgical technique known as "dispersion hardening," solid aluminum products reformed from *powdered* aluminum by heat and pressure take on new qualities. They are fine-grained, hard, tough, sapphire-like in brilliance, and amazingly resistant to heat effects.

ALUMINUM POWDER metallurgy products—"APMP" for short—are available in a family of four alloys. They are usually extruded into forms which can subsequently be further extruded, rolled, forged, drawn or impacted by conventional metal-working methods. Where you need the properties of aluminum, but where temperatures seem "too high" for conventional aluminum products, chances are that one of these four alloys may solve a host of hectic problems.

THE SUCCESSFUL development of these new APM alloys suggests what can happen when Alcoa research is applied to defense projects. We always stand ready to take on Research and Development assignments of a similar nature. For more information on APM alloys or Alcoa's R&D capabilities, write: Aluminum Company of America, 2026-W Alcoa Building, Pittsburgh 19, Pa.

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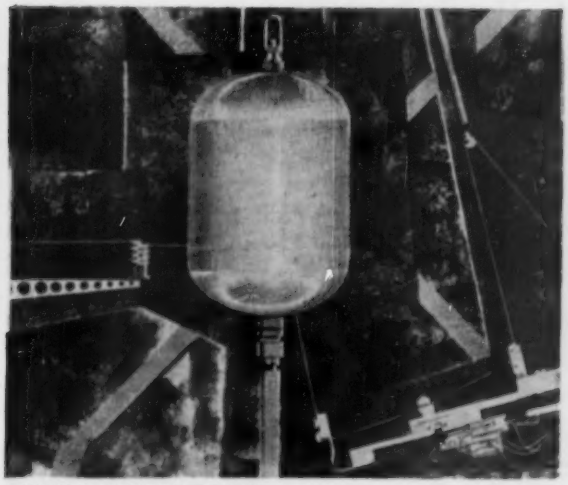

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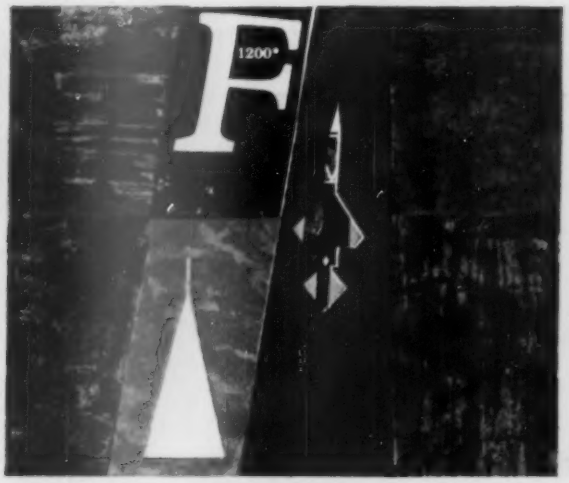

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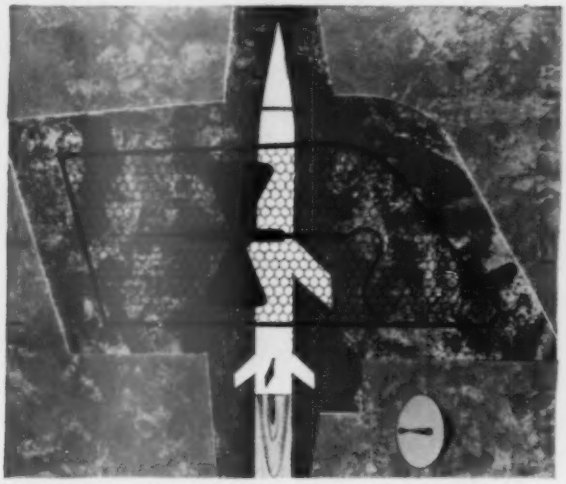

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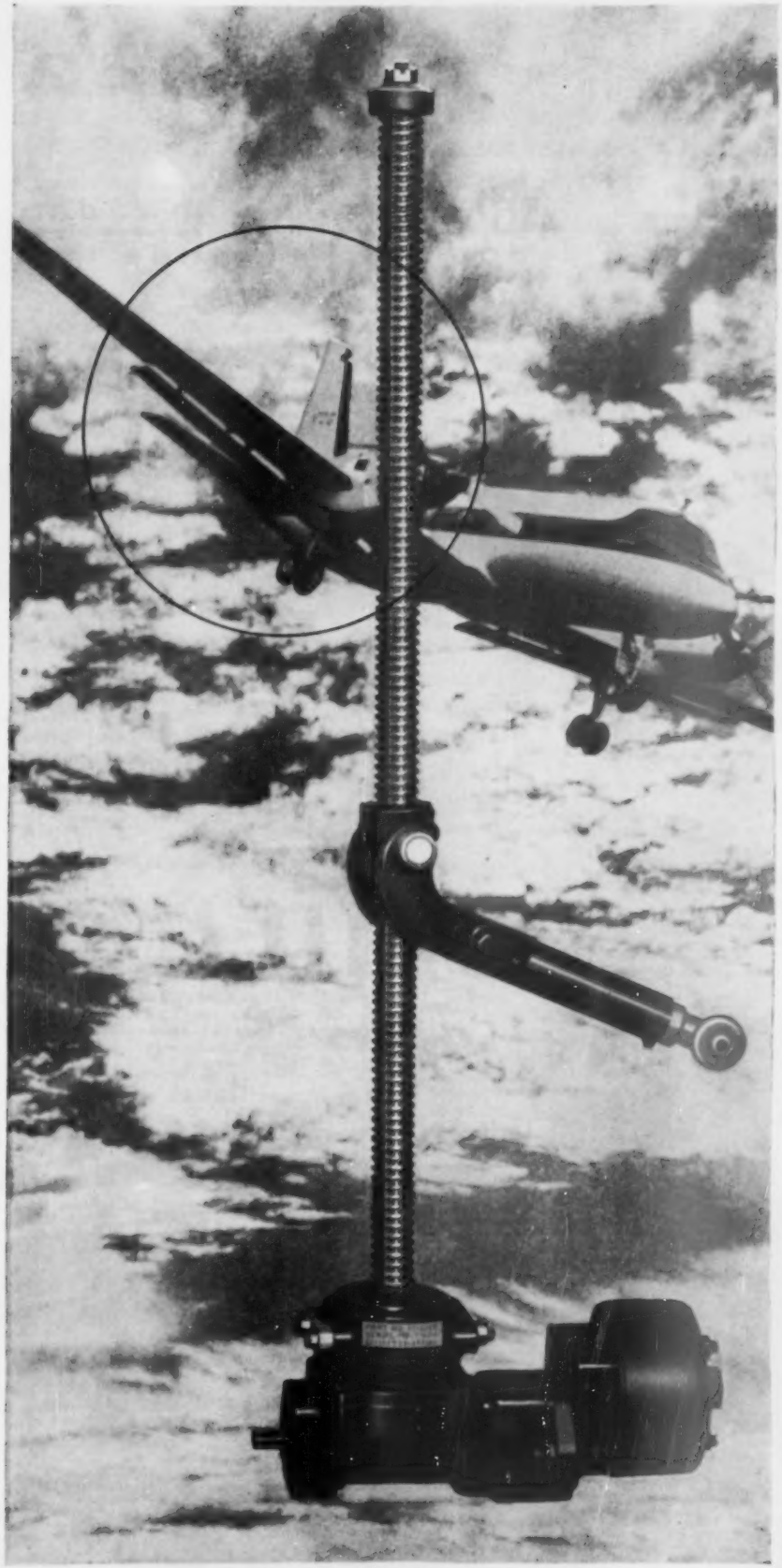

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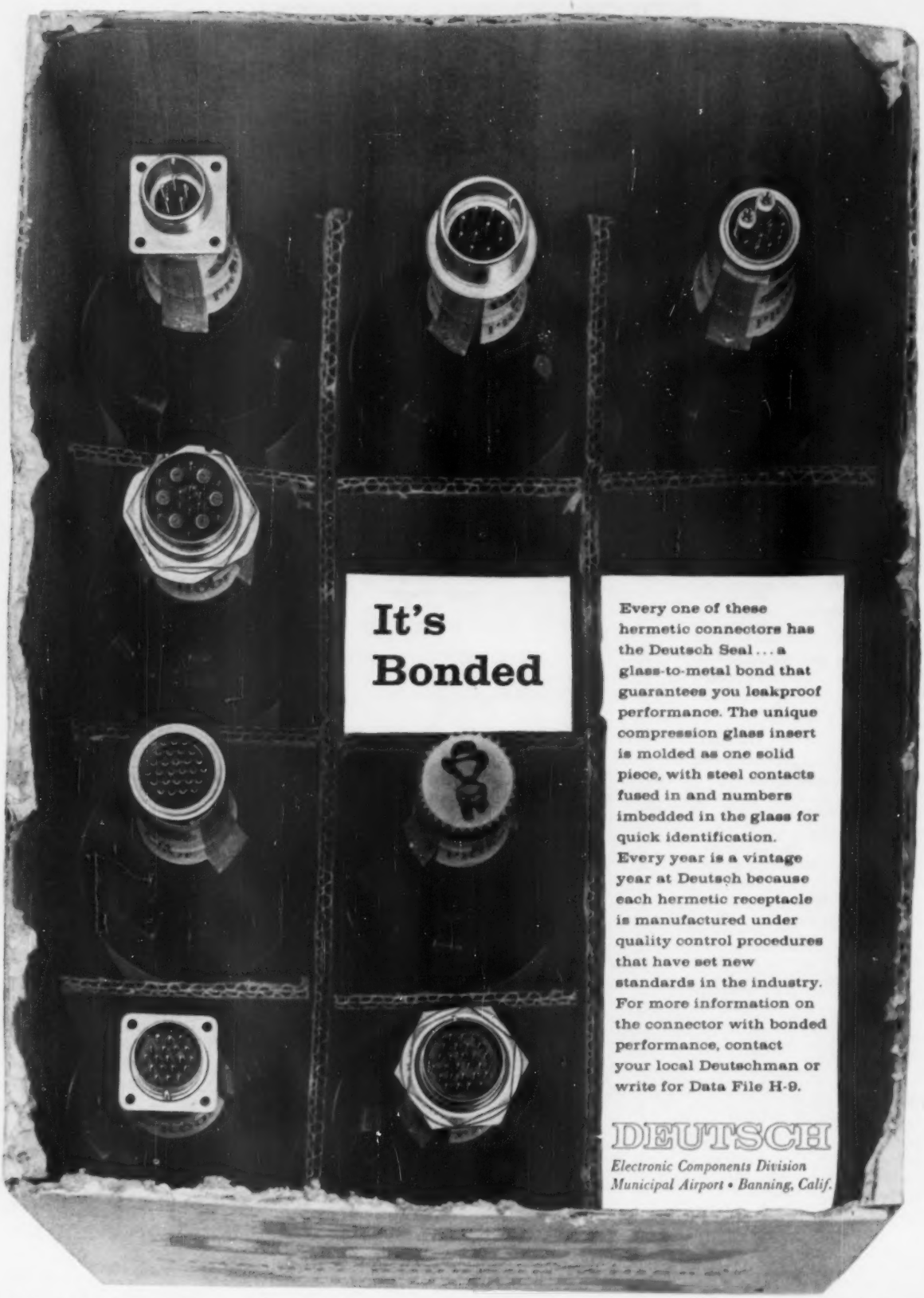
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EDITORIAL

'The Air Bites Shrewdly'

This quotation from Hamlet (Act 1, Scene 4), used by Danish poet Piet Hein in his prologue, "Heirs to the Air," composed specially for the opening session of the sixteenth annual general meeting of the International Air Transport Assn. at Copenhagen, certainly applies to these proceedings that transpired in the Danish capital last week. IATA has never met in a pleasanter city than Copenhagen but it has never seen so many seeds of internal dissatisfaction come to flower as in the meeting that just finished. At the same time, United States and Scandinavian delegations began negotiations on a new bilateral that promises to be typical of some bitter international rows ahead over traffic rights.

Both retiring President Seijiro Yanagita of Japan Air Lines and Ake Rusck, head of Scandinavian Airlines System who succeeds him in the IATA chair, made pointed references to the absolute necessity for freedom of the air in their opening addresses, although the Yanagita reference was aimed more at the Soviet Union whose sealing off of the vast Arctic airspace prevents real efficiency of polar routes. But no doubt remarks of Rusck and Danish Premier Vigge Kampmann were aimed at traffic rights restrictions they fear the U.S. intends to impose in current bilateral negotiations. Whatever the outcome of the series of bilaterals now being renegotiated, it is certain that the rigid structure of IATA is creaking like the rigging of a sailing ship in heavy weather under new pressures from member airlines who now discover that they have very little voice in major IATA affairs.

Unless this rigid structure is modified and some of the wind-filled sails are reefed, current controllers of IATA are likely to find themselves steering a dismasted ship, uncontrollable in the heavy weather of shrewd competition. Specific points of dissatisfaction with the IATA regime are varied but they all focus on the basic fact that many delegates to the annual general meeting are realizing for the first time that there are no opportunities for discussion on, or amendments to, IATA policies that are determined solely by the executive committee and the director general. Its discovery leads to a further analysis of executive committee composition which indicates it is dominated by a few of the world's largest airlines through their own memberships and appointments from their subsidiaries.

It also is apparent that with the current composition of the executive committee the director general wields considerably more authority than is consistent with the democratic procedures that IATA so firmly embraces in public.

Whatever the director general's past contributions to IATA may have been, and we suspect they are substantial, it is apparent that his British colonial administrator's approach to members is producing about the same effects in IATA that administration of the Stamp Act produced in American colonies nearly 200 years ago.

The current rebellion is still in its early phases and can be easily discounted by the incumbent IATA administration because few signs can be seen outside the secret sessions of the annual general meeting and other technical and traffic conferences. But those who saw seeds of this resentment sown in Tokyo note considerable growth of this feeling in a year's time and several specific incidents including the director general's peremptory ouster of the IATA traffic director, John Brancker, a man of unique ability in a difficult tariff area, have outlined the non-democratic processes of IATA more sharply. Although past annual general meetings have been largely social affairs for delegates and their wives, with working sessions merely rubber-stamping decisions already made by the executive committee and the director general, an increasing portion of them feel it no longer is worthwhile to travel so far for this purpose and that there must be some place in the procedural framework of IATA for fuller expression of views and debate before decisions are made.

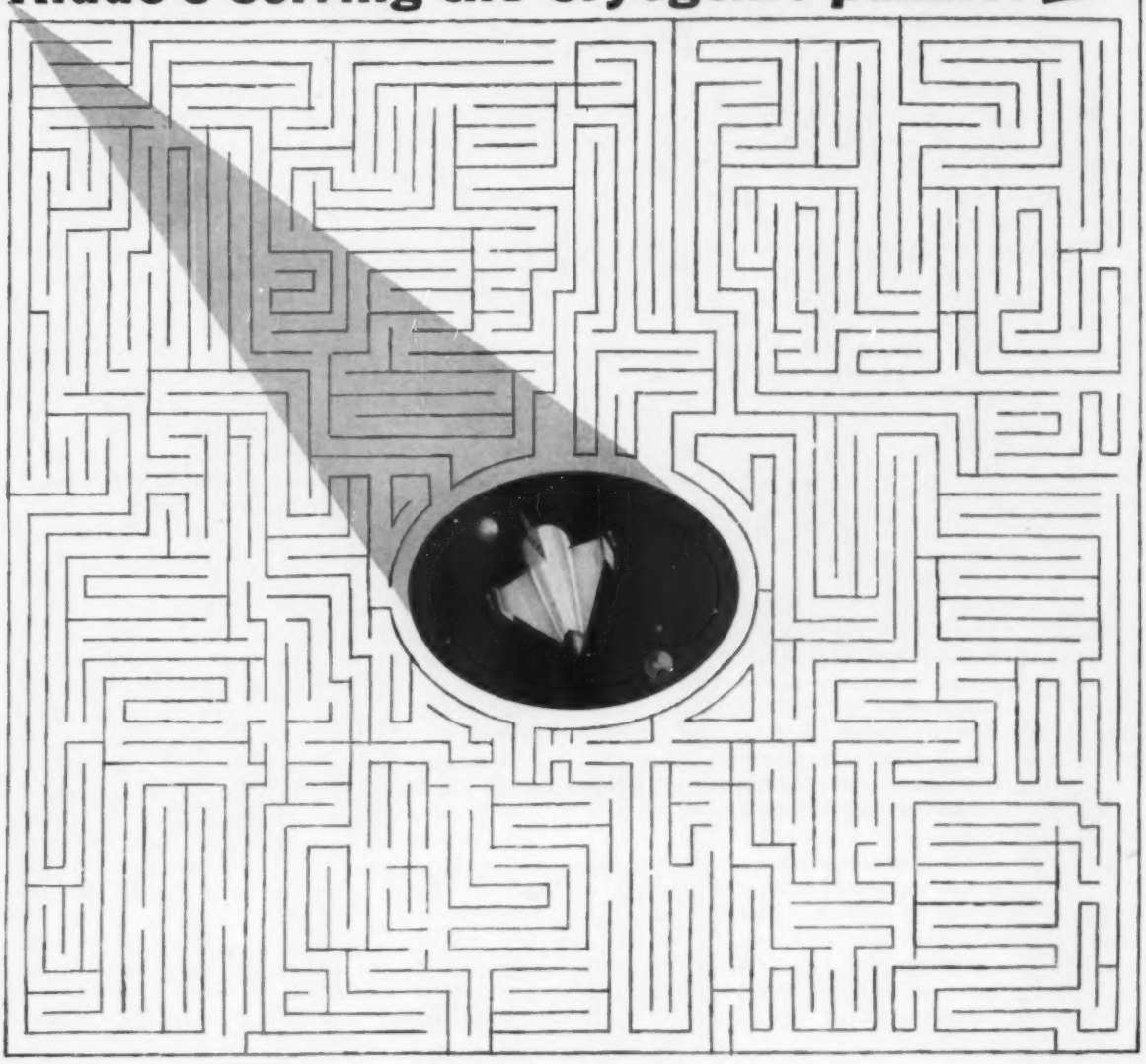
As an example, none of the reports made at the meeting are distributed to delegates in advance of their presentation. Since these are long and complex reports, it is impossible for delegates to either understand them without detailed perusal or to comment on them intelligently during the meeting. Similarly, nominations for selection of executive committee members were refused when offered from the floor with the suggestion that they be submitted later by letter. Another issue producing widely mixed reactions in Copenhagen is banning aircraft manufacturers from the IATA meeting area. The ban has not been 100% successful, with at least two non-American manufacturers in evidence, but many airline people, particularly from smaller operations, feel the ban has left a void in useful benefits they obtain from the annual general meeting because they are unable to arrange technical talks in ample free time between rubber-stamp business meetings and the evening social program.

Again large airlines that now dominate IATA policies have an ample opportunity for this type of technical discussion during the year but smaller operators do not. No doubt some manufacturers exhibited poor taste in behavior at IATA sessions, particularly in demanding entrance for themselves and their wives at IATA social functions, thereby putting a heavy burden on the host country and airline, and in failing to synchronize their activities with lulls in the IATA program. However, complete exile imposed by the executive committee of IATA does not really solve this problem and it should be worthwhile for both IATA and the airlines and manufacturers to work out practical ground rules for activities during annual general meetings.

As the director general of IATA noted in his opening remarks, turbulence is a hallmark of the contemporary world. His exhortation to delegates to stay in the IATA boat and stop rocking it toward a danger of capsizing probably would have carried more impact among delegates if they had been accompanied by more signs of democratic procedures in transacting business in this organization.

—Robert Hotz

Kidde's solving the Cryogenic puzzle!



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WHO'S WHERE

In the Front Office

William Kenneth Ebel, staff executive to the senior vice president for engineering, General Dynamics Corp., New York, N. Y. **Edward H. Higgins** succeeds Mr. Ebel as vice president-engineering of Canadair, Ltd.

Gifford K. Johnson, executive vice president, Chance Vought Aircraft, Inc., Dallas, Tex.

Gen. Frederick L. Anderson (USAF, ret.), a director, Astro-Science Corp., Los Angeles, Calif.

C. A. Patrizzi, a major stockholder, elected chairman of the operating committee and a director of Bone Engineering Corp. and subsidiaries, Glendale, Calif.

William E. Bratton, president, Librascope Division of General Precision, Inc., Glendale, Calif., succeeding **Lewis W. Imm**, resigned.

Herman Fialkov, president, General Instrument Corp.'s Semiconductor Division, Newark, N. J., and **Maurice Friedman**, executive vice president. Other Semiconductor Division appointments: **Kenneth C. Moritz**, vice president-marketing; **Dr. Bernard Jacobs**, vice president-research and development; **Jerry Fishel**, vice president-sales; **Bernard Cohen**, vice president-New York operations; **Norman Neumann**, vice president-Rhode Island operations.

Lt. Gen. Roger M. Ramey (USAF, ret.), president, Permanent Filter Corp., Los Angeles, Calif.

Paul S. Mirabito, vice president of Defense Contracts Organization, Burroughs Corp., Detroit, Mich.

Edwin A. Speakman, division vice president, Missile Range Programs, Government Services Department, Radio Corporation of America., Cherry Hill, N. J. also: **Stanley W. Cochran**, division vice ptesident and general manager, Surface Communications Division, and **Irving K. Kessler**, division vice president and general manager, Airborne Systems Division, RCA Defense Electronic Products.

Victor Kostuck, vice president, Leach Corp., Compton, Calif.

Rear Adm. H. C. Bruton (USN, ret.), vice president-planning, Military Products Division, Hoffman Electronics Corp., Los Angeles, Calif.

Burl S. Bishop, vice president-manufacturing, Transval Electronics Corp., El Segundo, Calif.

Gordon E. Frederick, vice president and technical director, Frederick Research Corp., Wheaton, Md.

John W. Buffington, assistant to the president, Grand Central Rocket Co., Redlands, Calif. Also: **Col. George Cechmanek** (USAF, ret.), corporate general counsel.

Col. Aldro Lingard, USAF, Acting Chief of the Test and Experimentation Division, Bureau of Research and Development, Federal Aviation Agency, Atlantic City, N. J., succeeding **Col. William S. Coward, Jr.**, retired.

Lewis N. Bayne, manager of the Federal Aviation Agency's Aeronautical Center, Will Rogers Field, Oklahoma City, Okla.

(*Continued on page 175*)

INDUSTRY OBSERVER

► USAF hopes to extend range and coverage of its SAGE air defense data link communications, used to direct manned interceptors and Bomarc missiles, by installing higher power transmitters and higher gain horn-type antennas. Program is expected to cost about $25 million and is scheduled for procurement this year.

► **At least 20 companies will collaborate with Battelle Memorial Institute in a new fuel cell research program. Companies which see some future for fuel cells as auxiliary space power sources will jointly underwrite venture with others. In turn, Battelle will supply technical facilities and scientific personnel, conduct research, and then pool results and proprietary rights with member companies.**

► Bendix has installed a company-developed flareout and de-crab instrumentation system in its North American B-25 at Teterboro, N. J., Airport to begin another phase of tests of Gilfillan's Regal landing system (AW May 18, 1959, p. 137). Tests will be run at National Aviation Facilities Experimental Center, Atlantic City, N. J., probably beginning this week, and will last one month. Company also has a PB-20 autopilot in its laboratories for changeover to complete solid-state transistorization.

► **All-weather version of Sidewinder air-to-air missile under development at Naval Ordnance Test Station will employ both infrared and radar target seekers in one head.**

► National Aeronautics and Space Administration's interest in more sophisticated satellite communications systems than passive Echo balloons has resulted in request to Hughes Aircraft to submit a proposal for a 24-hr. active communications satellite based on earlier company-funded studies.

► **Project TEAS (threat evaluation and action selection) is being run by USAF's Cambridge Research Laboratory to collect information for development of a command and control center that might be used by the Joint Chiefs of Staff after 1970. It would be an improvement on the concept of Project 473L, headquarters USAF command and control center. About $1 million has been spent on studies to date.**

► Thompson Ramo Wooldridge is proposing to Advanced Research Projects Agency a modified plan for satellite protection for area defense (SPAD).

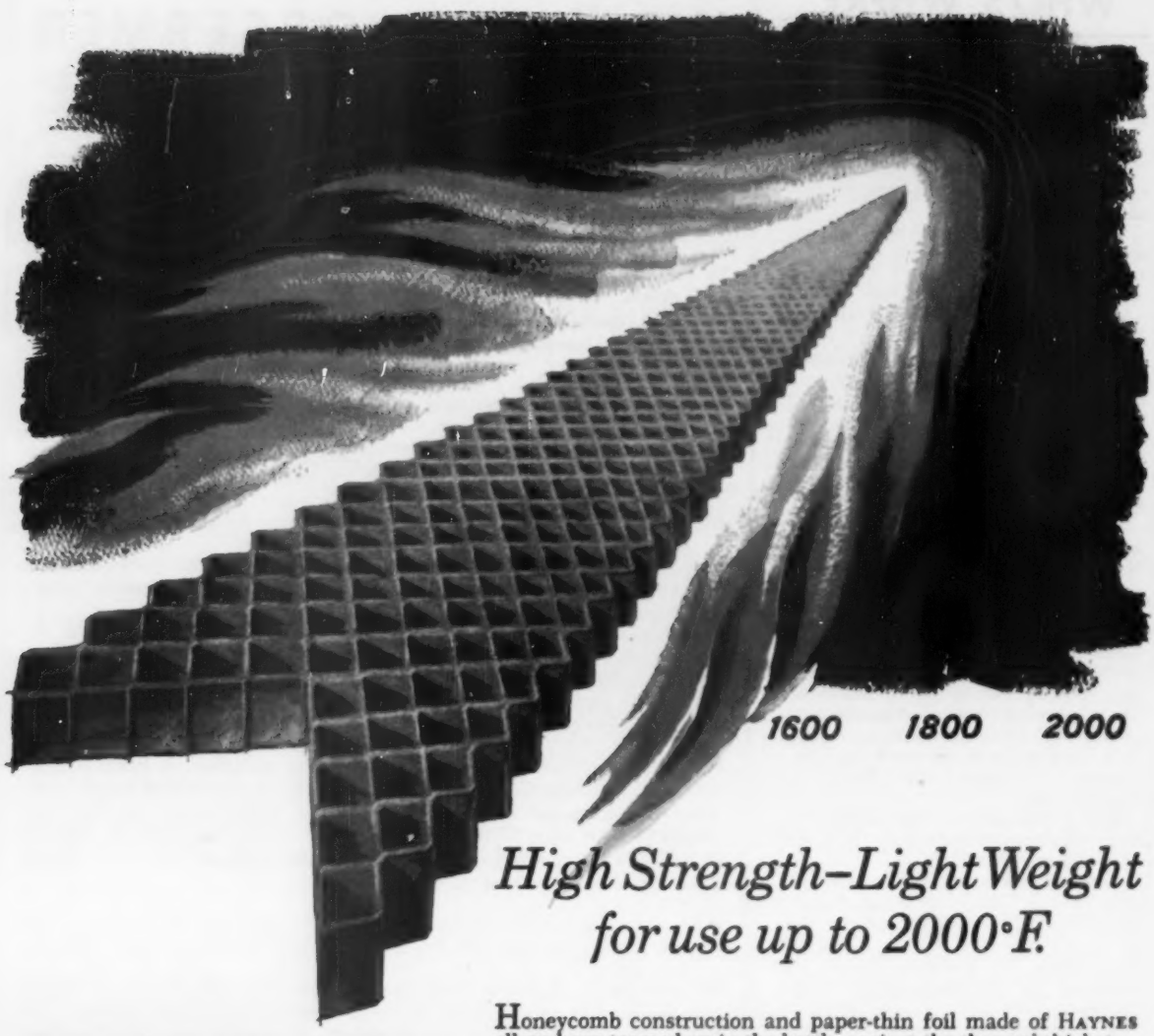
► **Vulnerability of transmitters, receivers and switching centers in global communications system 480L is being studied by General Electric and Planning Research Corp. Cost advantages of dispersal are being weighed against cost of site hardening for a given level of invulnerability of the complete system.**

► Winter Study Group report outlining USAF electronic support system requirements for the coming decade is expected to be presented to USAF Secretary Dudley Sharp and Asst. Secretary Joseph V. Charyk next week, and Command and Control Development Division, the study's sponsor, will seek approval for releasing a "sanitized" version of the report to industry.

► **First flight test of the USAF Minuteman solid propellant intercontinental ballistic missile could come as early as December but may not occur until January or February. USAF now expects Minuteman to be operational by mid-1962, some 18 months ahead of original target date.**

► Nuclear facility at Wright Air Development Division, originally begun on crash basis for engineering tests of components and subsystems for nuclear-powered aircraft, now is two years behind schedule because of program stretchouts. Original cost estimate of $8 million has been spent and another $8 million is needed but low priority makes funds difficult to obtain.

► **One of the two Sikorsky S-58 helicopters ordered for the use of Russian Premier Nikita Khrushchev is currently flying at the manufacturer's Stratford, Conn. plant. There are no insignias on the aircraft, but its paint job includes a broad red horizontal stripe. No delivery date has been set on the Russian order.**



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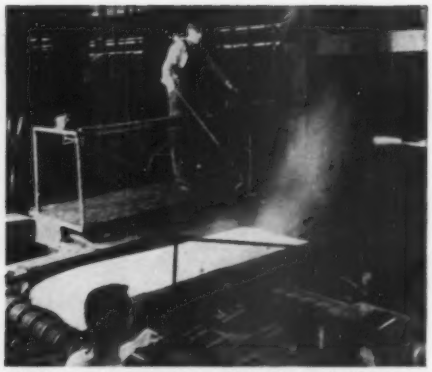
HAYNES high-temperature alloys are produced in many other forms, too. Sheet, plate, bar stock, wire, tubing, and castings are all immediately available. For full information, write for descriptive literature.



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Washington Roundup

Arms Control Agency

More than a year of study and debate has ended in the creation of the U. S. Disarmament Administration within the State Department. Soviet Russia's expert use of the nuclear testing and arms control issues as propaganda devices has often caught the U. S. off base, causing considerable criticism within and outside of government.

Lack of a clear-cut U. S. position has been due partly to the conflicting needs and interests of State, Defense Department and the Atomic Energy Commission. Groups that studied the problem generally agreed that a central body to advise on policy was needed, but State, Defense and the White House staff have engagd in a three-way pulling match over where it should be located within the government.

Sen. John Kennedy, Democratic presidential candidate, may have inadvertently delayed formation of the arms control group last spring when he proposed such a body in a major speech—scooping the Administration on a suggestion made in a still-secret report by the Coolidge Committee Disarmament Study Panel. Although others, including Sen. Hubert Humphrey, had made similar suggestions before, the fact that Kennedy was for it meant that the Administration could not immediately take an action that a Democratic candidate had just recommended.

Not the least of the internal squabbles over arms was whether the words "arms control" were preferable to "disarmament." State picked the latter. The new agency's mission is to "marshal in a single unit political, military, scientific and technical skills" in an attempt to "discover reliable means for easing the burden of armaments, lessening the dangers of war by miscalculation, and helping to promote a just and durable peace."

Khrushchev's Security

Exchange of unpleasantries that has marked U. S.-USSR relations since last May when the U-2 went down inside Russia continues. State Department's restriction of Soviet Premier Khrushchev to Manhattan Island during his attendance of the United Nations session was attributed primarily to concern for his security. State said assuring this security for the premier and his delegation has been complicated by the hostile public statements he has made and "by the destruction of an American [RB-47] plane over international waters by Soviet action and the continued illegal detention of two American flyers."

Attempts to demonstrate the operational readiness and accuracy of the first U. S. ICBM, the USAF-Convair Atlas, have been disappointing. Three recent tries to fire Atlases from Vandenberg AFB, Calif., into Eniwetok Atoll have failed. The first was aborted on the pad, the second missile was destroyed shortly after takeoff and the third shot last week—in which three missiles were counted down just for insurance—missed its mark by a considerable distance. On at least two of the tries, SAC Commander Gen. Thomas Power was circling near the atoll in his KC-135 command aircraft. More shots are planned.

Defending Mercury

Unhappy with continuing criticism of Project Mercury, NASA officials are taking the offensive. George M. Low, chief of manned space flight, said termination of Mercury most certainly would keep the U. S. in second place in space. The program was begun with a clear understanding that Russia probably would be first in manned orbital flight—and if Russia would exchange information the U. S. might be able to skip some steps. Since this is unlikely, Mercury is a necessary step toward Apollo, the proposed multi-man satellite. Vigorous implementation of Apollo could give the U. S. leadership in space, Low said.

Defense of Mercury extends even to the program's public relations aspects. Life magazine has a controversial contract with the seven astronauts for exclusive rights to their personal stories. Nevertheless, the astronauts have been the subjects of six press conferences, two press tours, an interview session, 89,000 words in transcripts and releases, 600 still pictures, 6,000 ft. of movies, five picture-taking sessions and 56 visits to Space Task Group by newsmen, Public Information Director Walter T. Bonney told a group of editors.

Wrapup

Air Force and Defense Department are trying to arrive at a mutually acceptable B-70 program. ARDC has submitted a variety of possible combinations. . . . ARDC Commander Lt. Gen. Bernard A. Schriever insists that no basic changes in responsibilities will result from current ARDC-AMC talks—only realignment of certain procedures, possibly involving the operational commands. Also . . . Dr. Herbert York, recovering from a heart attack, plans to return to his job as director of research and engineering in Defense Department, probably in mid-November and possibly on a part-time basis at first.

—Washington Staff

Space Technology

New Capsule to Be Developed for Samos

Short timetable and demanding requirements indicate urgency of plugging broad U. S. reconnaissance gap.

By Larry Booda

Washington—Air Force has taken a step beyond the present Samos reconnaissance satellite system by asking 11 companies to bid on development of a more sophisticated capsule in a tightly compressed nine-month time schedule.

The move comes as a number of top defense and Administration policy-making groups are meeting to make hard decisions on satellite reconnaissance feasibility, legality, and diplomatic implications.

Decision follows other steps taken recently to relieve the pressures built up since early May, when shooting down of the U-2 reconnaissance aircraft by Russia created a serious loss of intelligence information, particularly that regarding Soviet intercontinental ballistic missile launching sites (AW Sept. 12, p. 31).

Bids Due Oct. 13

Bids for the new capsule, designated E-6, are to be submitted by Oct. 13 and prototype hardware is to be delivered nine months from initiation of the work.

In order to make the new capsule an advance over the present Lockheed Samos E-5 capsule, proposals are to include dual approaches:

- **Recovery of an entire** 3,000 lb. capsule.
- **Recovery of multiple** instrument packs.

Companies expected to submit proposals are Bell, McDonnell, Hughes, Boeing, North American, Douglas, General Electric, Aeronutronic, Temco, Chance Vought and Martin.

Lockheed was not requested to participate, probably because of its current heavy workload with Discoverer, Midas and Samos.

First indication of a concentrated effort to speed up Samos came with the shift of Brig. Gen. Richard B. Curtin to a newly created office directly under the Secretary of the Air Force. The office, which formerly coordinated satellite development systems for the Air Force Chief of Staff, now assumes coordination functions on an interagency basis, with USAF named as executive agent for the Administration.

Through this office the satellite efforts of the military services will be tied in more closely with the work of the Central Intelligence Agency, the Atomic Energy Commission, the National Security Agency and other related agencies in the executive branch.

Lt. Gen. Bernard A. Schriever, commander of the Air Research and Development Command, would not comment specifically on any change in the Samos program last week, but he said: "We have been considering for some time plans to expand our efforts in satellites. . . . You can expect increases in all satellite areas." This indicates a widening of the area of interest by including reconnaissance, early warning systems such as Midas, and communications satellites.

More Funds Needed

Asked what USAF programs might be curtailed to furnish money for the extra satellite effort, Schriever said: "If we are going to get the job done that I think needs to be done, we are going to have to spend more money for defense. . . . We cannot maintain an effective force in being and also move into the space age without paying for it."

However, it was learned that an extra $83 million has been made available by Secretary of Defense Thomas S. Gates, Jr., to back the speedup, bringing the total in the current budget for reconnaissance satellites close to $300 million. The effort may require even more than that in the current fiscal year, and some temporary adjustment might have to be made in Air Force budget allocations pending possible emergency action in the next session of Congress.

The concept of reconnaissance, early warning and communications satellites had its inception in 1957 with WS-117L. A team at the Ballistic Missile Division soon developed separate programs or steps, beginning with the Discoverer series of polar orbit capsule recovery flights. Two other programs, the Midas early warning infrared satellite and the Samos photographic reconnaissance vehicle, were designated E-4 and E-5.

Versatility Planned

Although the basic E-6 satellite capsule will have to be limited to a 3,000 lb. weight, it will incorporate versatility by carrying smaller capsules, or instrument packs, of varying size and weight, with a capability of injecting each capsule into a recovery trajectory on command or by preprograming.

Targeting Unit Grows

Omaha—Organization of interservice Strategic Targeting Unit under Strategic Air Command Commander Gen. Thomas S. Power (AW Aug. 22, p. 36) is proceeding on a crash basis. Officers are being ordered to SAC headquarters from the services and the major unified commands with as little as 24 hr. notice. Most are leaving their families behind, hoping to find housing at a later date.

Problems facing the unit are many, with the gap in photographic intelligence making the job more difficult. Added to this is an uncertain amount of error in the geodesy of the entire Eurasian grid system, amounting in many instances to five miles or more. Combination of these two factors with the still imperfect accuracy of the intercontinental and fleet ballistic missile will give the target planners an error constant which could result in the necessity of multiplying the number of missiles assigned each target.

Midgetman Presentations

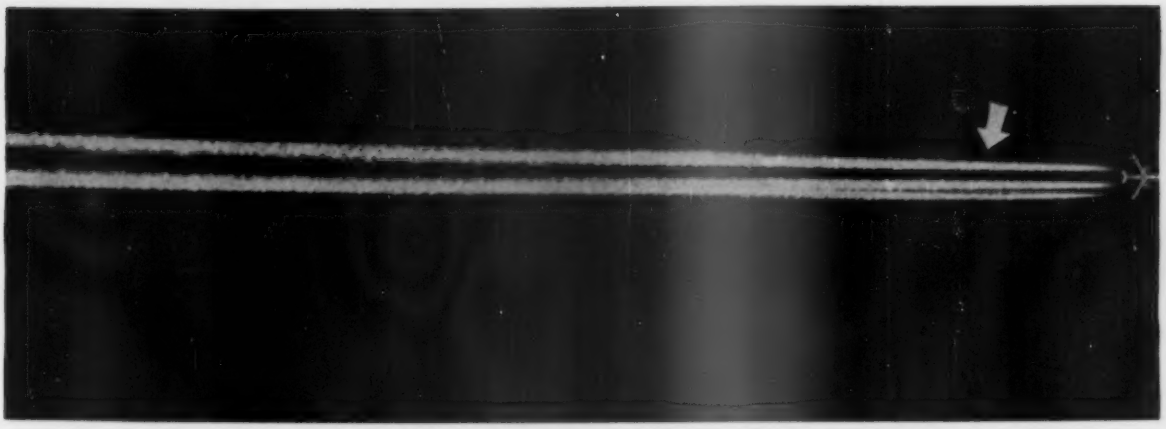
Washington—Approximately 18 industry companies with systems capability have submitted presentations to Air Force's Ballistic Missile Division on the small mobile ICBM (AW July 18, p. 26), generally referred to as Midgetman in the industry.

Presentations, made early this month, were not specific proposals but were in form of general projections on how the Midgetman mission could be accomplished efficiently, with cost estimates included.

BMD will study the presentations and forward them this month to Air Research and Development Command headquarters, with comments. After intensive study at ARDC, recommendations are expected to be forwarded to USAF headquarters.

General projections for Midgetman include a missile about 30 ft. long, weighing about 25,000 lb. with associated environmental control equipment and other components. Total weight of the weapon system probably will be close to 45,000 to 50,000 lb.

For adequate range as a small ICBM, missile probably will be a three-stage configuration of solid propellants with specific impulses in current use forming the basis of the design.



Contrail Elimination System Installed on B-47

Extensive reduction of contrail visibility has been achieved by Cornell Aeronautical Laboratory, Inc., after extensive research on contrail causes and physical makeup. System is installed here on Boeing B-47 jet bomber's left outboard engine. Modified blow torch, burning jet fuel, was used to develop miniature contrails in an altitude chamber as part of the basic research.

Such a satellite could provide electronic readout pictures via a videoscope scanning, magnetic recording and playback telemetry system, or could return capsules for recovery which contain conventional but improved light sensitive emulsion photographic equipment.

A renewed interest in conventional photography and video readout has been generated by the success of the Tiros weather satellite, which transmitted back pictures taken with a relatively unsophisticated lens system.

A satellite such as E-6 would involve extensive changes in the second stage from the Agena B satellite of the Samos series. It can be assumed, however, that no engine change would be made because of the urgency of the program. The Bell Hustler engine has proved itself highly reliable in injecting capsules into their recovery trajectory, and no substitute exists which would not require time consuming testing.

Mechanics of choosing companies to submit proposals were begun about three weeks ago by a source selection board at the Ballistic Missile Center of the Air Materiel Command at Los Angeles, which handles contract negotiations for ARDC's Ballistic Missile Division. Considerable effort went into changing specifications for guidance of the companies submitting proposals.

Importance of time as a factor in the Samos program can be deduced from consideration of several factors:

- **There has been no photographic** reconnaissance of Russia since the U-2.
- **The Russians are making** an all-out effort to shift intercontinental ballistic missile-launching sites to new locations.
- **As time goes by these launching** sites will be less vulnerable to aerial photographic reconnaissance as vegetation grows over them.
- **It can be assumed that Russia** will have a satellite intercept-destruct capability by 1963.

Space Coordinating Board Created

Washington—Formal coordination of civilian and military aeronautics and space programs has resumed after eight months with establishment of an Aeronautics and Astronautics Coordinating Board composed of active research program directors.

Lack of formal coordination between National Aeronautics and Space Administration and Defense Department had existed since January when the Space Council and the Civilian-Military Liaison Committee essentially ceased operations. Informal coordination on joint programs was the practice, but it was done by policy rather than by statute.

New board, under the joint chairmanship of Dr. Hugh L. Dryden, NASA deputy administrator, and Dr. Herbert F. York, director of defense research and engineering, functions under a NASA-Defense administrative agreement signed in July.

Operation of the Space Council and the CMLC proved cumbersome and ineffective when both NASA and the military found it impractical to delay programs until these groups took policy actions.

The new board is expected to streamline liaison with frequent meetings of panels on specific problems.

Formation of the board follows strong recommendations by NASA and the military which resulted in a House action (AW Mar. 21, p. 30) to amend the 1958 Space Act. Senate has not acted on the bill (H. R. 12049) and existence of the Space Council and CMLC remain statutory requirements. The House recommended that the new coordinating board be created by statute, rather than by administrative action, as was done.

Panel chairmen, along with Dryden, York and two members-at-large, constitute the new board, which will meet at least bimonthly. Its basic responsibilities are planning review, coordination, problem identification and information exchange.

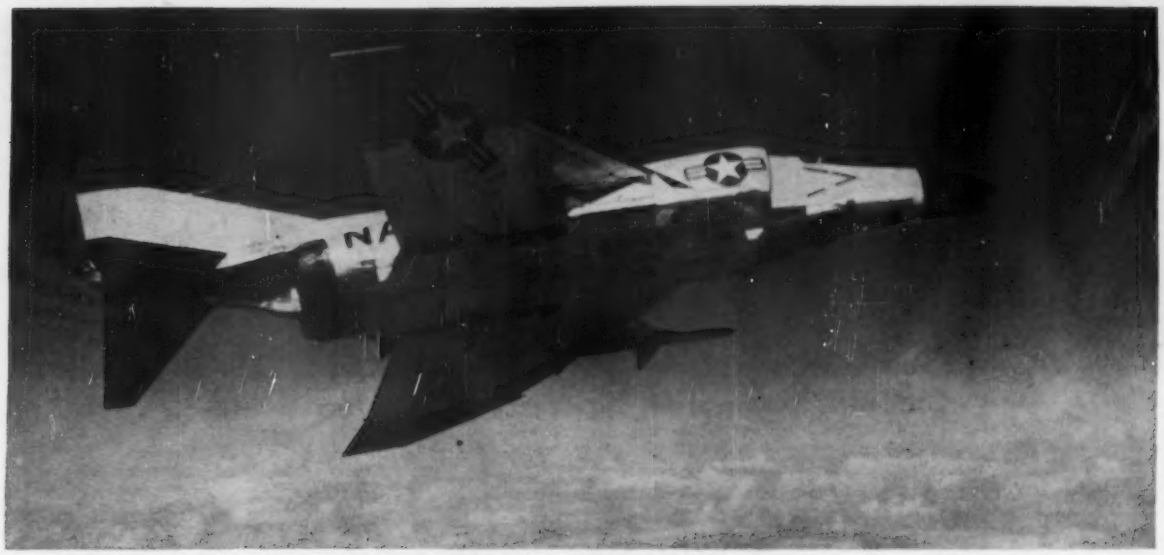
Panels created so far and their chairmen are: Launch vehicles—Dr. Courtland D. Perkins, assistant secretary of the Air Force for research and development; manned space flight—Dr. Abe Silverstein, NASA director of space flight programs; space flight ground environment—USAF Lt. Gen. Donald N. Yates, deputy director of defense research and engineering; unmanned spacecraft—Dr. Homer E. Newell, NASA deputy director of space flight programs; supporting research and technology—Ira H. Abbott, NASA director of advanced research programs; and aeronautics—Vice Adm. John T. Hayward, deputy chief of naval operations (development).

Members-at-large are Richard S. Morse, Army director of research and development, and Dr. Robert C. Seamans, Jr., NASA associate administrator.

Lockheed Ship to Serve As ASW Laboratory

Los Angeles—Floating anti-submarine warfare laboratory owned by Lockheed Aircraft Corp. will be launched next month to conduct oceanographic research in conjunction with present company ASW research activities.

The former Puget Sound, a 50-ft. steel trawler, is being converted into a basic research vessel by a San Diego shipyard. The vessel has a 12.5-ft. beam, 6-ft. draft, fully-loaded displacement of 70 tons.



McDonnell Phantom II Mounts Six Sparrow Missiles

McDonnell F4H-1 Phantom II jet fighter for U. S. Navy carries six Sparrow III missiles slung under wings and belly; this is first photo of the airplane with Sparrows attached to new under-wing missile racks. Missiles carried on the belly section are semi-recessed.

Large Solid Space Boosters Studied

By Edward H. Kolcum

Washington—Studies of solid propellant rocket motors capable of boosting 1-million lb. and 7-million lb. space vehicles are being initiated by National Aeronautics and Space Administration to determine whether solids can compete with liquid engines for major space applications.

These vehicles—in the Saturn and projected Nova weight-lifting classes—would be the first "super boosters" combining solid first stages with liquid upper stages. Upper stages would be the highly promising liquid hydrogen rockets now under development by NASA.

Three companies—Aerojet-General Corp., Grand Central Rocket Co., and Thiokol Chemical Corp.—have been selected from among seven firms submitting proposals for wide-ranging investigations of large solid boosters. They will share approximately $225,000 for concurrent, six-month NASA studies on two specific vehicles.

Thrust-Weight Ratios

Both vehicle concepts envision use of two or three hydrogen-oxygen upper stages. Systems would have gross takeoff weights of one million and seven million pounds, with about half the liftoff weight concentrated in the solid first stage, giving them about as much better thrust-to-weight ratio in the first stage than the large liquid rockets will have.

Three-stage configurations would be used for earth orbital missions, and four stage vehicles for planetary flights.

Robert A. Wasel, manager of NASA's advanced solid propulsion technology programs, said that although no experience exists in giant solid boosters, potential advantages of solids over liquids for large applications were indicated in separate studies conducted for NASA last year by Lockheed Aircraft Corp. and Aeronutronic Division of Ford Motor Co. Coming studies will extend those of Lockheed-Aeronutronic, which used estimated design data to determine the value of further investigations.

In addition to the obvious gains in handling and storing, these NASA studies concluded that solids are theoretically more efficient because they can readily develop desired higher thrust-to-weight ratios and suffer less gravitational loss than the longer-burning liquid boosters.

With this characteristic, a solid booster stage could be built perhaps 30% smaller than a liquid with the same mission, and more weight could be added to the efficient hydrogen-oxygen upper stages and payload.

First stage for a 1-million lb. gross liftoff weight vehicle using a solid booster would weigh about 500,000 lb. By comparison, the all-liquid Saturn C-1 configuration, with a gross takeoff weight of about 1.16 million lb., will have about 80% of the total vehicle weight in its first stage.

Wasel said big solids cannot now compete with Saturn-type engines because Saturn is well into development and comparable solids are theoretical, but he feels that additional studies will show solids in a position to compete with liquid propellants in cost and performance.

Areas of Exploration

Before major funding or research efforts can be pushed in big solid boosters, NASA feels it must go beyond the broad parameters of the Lockheed-Aeronutronic studies into these areas:

- **A general feasibility definition** of the large solid first-stage concept using current technical knowledge.
- **Optimum vehicle configuration,** including recommendations for segmenting, clustering, nozzle arrangement or constructing a single massive piece of propellant. Segmented solids should offer the advantage of the flexible, building-block approach (AW June 13, p. 28).
- **Definition of a logical** development program for large solid rockets.
- **Detailed cost analysis** for an over-all program, including per-pound payload cost and optimum economical payload.
- **Methods of steering,** using fins, vanes, jetavators, verniers or other techniques.
- **Methods and parameters** for destruction.
- **Procedures for quality** control.

NASA hopes to obtain detailed answers to these problems from three different viewpoints in the Aerojet, Grand Central and Thiokol studies.

Several concurrent projects sponsored by NASA and the Defense Department are expected to complement the coming large booster feasibility study. NASA recently completed negotiations with Rocketdyne for $44 million development program for J-2 hydrogen-oxygen Saturn upper stage which could be the upper stage for the large solid; Air Force has a $4 million contract with Aerojet aimed essentially at determining the feasibility of manufacturing large segmented solid rockets and NASA has a $148,000 contract with United Technology Corp. to build and test fire three 3,000-lb. solid motors, each made in three segments.

NASA also expects to take advantage of nozzle materials and other new developments in Minuteman, Polaris, Pershing and Zeus programs.

Rocketdyne said last week that negotiations with NASA had been completed for 4½-year development and qualification program for the J-2. Earlier estimates gave development time as three years (AW June 6, p. 32).

Air Force estimates that large, segmented boosters eventually will give up to four times the impulse of Minuteman, which is the largest solid motor now under development for a specific mission. Grand Central is providing supporting research in the segmented studies.

NASA expects to static fire the United Technology segmented rockets early next year, and both NASA and Air Force are looking at segmented concepts as they facilitate storage, shipment and assembly. Both are also interested in possible means for patching deficient pieces of propellant so that entire motor would not have to be discarded.

Boeing Engineers Reject Proposal

Boeing Airplane Co. engineers at Wichita, Kan., and Seattle, Wash., have rejected the company's offer in the 1960 collective bargaining negotiations. The Seattle Professional Engineering Employes Assn. complained that Boeing's offer consisted solely of "reductions in existing benefits."

Group represents 8,900 Boeing engineers.

The company offer eliminates a clause providing two weeks' notice prior to layoff and removes any restrictions on the criteria to be used in selecting which engineers would be laid off. The company has offered a 3% general increase, abandoning terms of the past four years under which the salaries of experienced engineers were adjusted by the amount which beginning salaries increased in the preceeding year.

Kennedy Names Defense Reviewers

Washington—Democratic presidential candidate Sen. John F. Kennedy (D.-Mass.) last week named five prominent attorneys with previous government experience to a special committee under Sen. Stuart Symington (D.-Mo.) to review the organization and management of the nation's defense structure. They are:

- **Thomas K. Finletter**—Secretary of the Air Force from 1950 to 1953 and chairman of the President's Air Policy Commission from 1947 to 1948.
- **Clark M. Clifford**—Special counsel to the President from 1946 to 1950. He helped draft the National Security Act of 1947, and was naval aide to the President in 1946.
- **Roswell L. Gilpatric**—Under Secretary of the Air Force from 1951 to 1953 and a member of the Rockefeller Special Studies Project from 1956 to 1957. He also was a member of the Advisory Panel to the Joint Congressional Subcommittee on Military Application of Atomic Energy.
- **Fowler Hamilton**—Chief legal counsel, Department of Justice in 1945, general counsel of the Senate Subcommittee on Airpower in 1956 and chief of the Enemy Branch of the Foreign Economic Administration from 1942 to 1943.
- **Marx Leva**—Special assistant to the Secretary of the Navy in 1947 and special assistant and counsel to the Secretary of Defense from 1947 to 1949.

Dr. Edward C. Welsh, legislative assistant to Sen. Symington since 1953 and deputy administrator of the Office of Price Administration from 1946 to 1947, will serve as executive director.

The committee's work will be focused on administration and management of the Defense Department and related agencies and organizations, Kennedy said. It will deal with such matters as the relationships between civilian and military, decision making in the Defense Department, the role of the Joint Chiefs of Staff and the lag time in new weapons.

"The crucial questions," Kennedy said, "are those of judgment as to what changes should be made in the organization and administration of our defense agencies to eliminate or at least to diminish the present crippling effect of these problems upon our defense power."

He said the committee will seek the views of each military service and of defense industries as well as qualified and experienced civilians, regardless of their political affiliation or particular service backgrounds.

"We must improve the administration of our defense agencies and we must do it without delay," Kennedy said. "To that end, the committee will make recommendations to me as to the measure, whether legislative or executive, that should be taken to achieve two primary and related objectives—to obtain a defense adequate to protect the nation and enable it to discharge its international responsibilities, and to obtain such a defense within the framework of a free and solvent economic system."

Navy Accepts First Piper Aztec Twins

First of 20 Piper Aztec twins ordered by U. S. Navy and designated UO-1 have been delivered to Anacostia NAS, Washington, D. C. Paint design is red, white and black. UO-1 ground support and spares will be handled through Piper service organization.

Techniques of 'Project Needles' Detailed

By Philip J. Klass

Lexington, Mass.—First details on "orbital scatter communications," a promising new technique that will use earth-circling belts of millions of tiny hair-thin metallic whiskers, were disclosed here by Lincoln Laboratory which has been investigating the technique with Thompson Ramo Wooldridge under Defense Department sponsorship.

Scientists will attempt to place such a belt of metallic whiskers into orbit in the next few months as a "piggyback" experiment aboard another satellite (AW Aug. 1, p. 23; Aug. 22, p. 105).

ORBITAL SCATTER communications, using two or more belts of millions of tiny metal whiskers in orbit around earth, could provide continuous near-global coverage. Technique was developed by Lincoln Laboratory and Thompson Ramo Wooldridge Corp.

Signal Belt

The belt will consist of millions of tiny metal whiskers, or dipoles, less than 0.001 in. in diameter and about 0.8 in. long. The dipoles, weighing about 220 lb. per billion, will be ejected from a satellite as it circles the earth. The result will be a continuous belt of signal-reflecting surfaces which appear to remain fixed in space. An orbital belt in an equatorial orbit, at any altitude, would remain fixed with respect to earth stations except for small orbit perturbations.

Lincoln Laboratory studies indicate that if the tiny dipoles are ejected along a satellite velocity vector with a distribution of velocities of up to a maximum of plus or minus 10 fps., the belt laid down will close upon itself in roughly one month and will assume a reasonable degree of uniformity in two months.

If dipoles are ejected in all directions, the belt can be expected to spread about 20 mi. in a direction radial to earth (thickness) and about 5 mi. in width, with the bulk of the dipoles concentrated in a narrow portion of the belt. Average separation between individual dipoles in a 3,000 mi. orbit would be about 1,000 ft.

MILLIONS of tiny metal whiskers, less than 0.001 in. in diameter, will be ejected into orbital belt by dispenser satellite. A billion of these tiny dipoles, weighing 220 lb., can create suitable belt.

Once the orbital belt of dipoles is created, it can be used in much the same way as a passive communications satellite, with ground stations reflecting signals off the belt.

Technique's Advantages

In a report delivered in London at a recent meeting of the International Scientific Radio Union, Lincoln Laboratory's W. E. Morrow, Jr., cited these advantages of the new technique, compared with conventional passive communications satellites:

- **Two dispenser satellites** could produce two orbital belts, one in an equatorial orbit and the other in a polar orbit, which could jointly provide global coverage. Belts should have a lifetime of several years before dipoles become dispersed enough to require replacement.
- **Ground station antennas** used with an orbital dipole belt, even one in a low orbital altitude, need only be able to shift aim by a few degrees per day to accommodate slight perturbations in its orbit. Antennas required for passive communication satellites in other than synchronous equatorial orbits must be able to track them at relatively high speed, increasing antenna cost and complexity.
- **Considerable number** of simultaneous communication channels can be provided by a single belt of dipoles because of the large number of scattering (reflecting) locations available around the earth.

Basic Concept

The basic concept of orbital scatter communications is credited to Morrow and Harold Mever of Thompson Ramo Wooldridge Corp. Investigation of feasibility, conducted under the code name Project Needles, was recently declassified to permit State Department to advise other nations of the forthcoming experiment. Unannounced purpose of Morrow's report was to explain the technique to international radio scientists and to reassure them that dipole belts would not interfere with radio astronomy, space communications or other space experiments.

The movement of the tiny dipoles in

orbit through the beam of a fixed ground antenna will create some disadvantageous propagation characteristics, Morrow pointed out. When antennas with beamwidths of a fraction of a degree are used, so that the belt fills the beam, multipath delays of 100-300 microseconds can be expected. More serious is the fact that motion of the dipoles will cause multipath delay to change at a rate of 200 to 1,000 times per second. This "doppler smear" characteristic suggests the use of noncoherent pulse code modulation techniques for the best results, Morrow indicated.

This multipath delay is comparable to that now obtained with ionospheric scatter but the fading rate is about 300 times higher. Morrow believes that the use of digital transmission techniques, both for data and voice, will be necessary to cope with these limitations of the dipole belt.

Using a belt produced by approximately one billion dipoles, weighing 220 lb., at an altitude of several hundred thousand feet, should provide communication data capacity of "a few tens of kilobits per second" at frequencies in the microwave band, Morrow predicted. Ground stations would have antennas of 60 ft. dia., a transmitter with an output of 10 kw., receivers equipped with low-noise Masers.

Data capacities of up to one million bits (one megabit) per second could be achieved if a larger mass of dipoles was used to produce the orbital belt, Morrow indicated.

No Interference Expected

The use of a belt of tiny dipoles has several advantages over other types of reflectors, in addition to those cited earlier. Because the dipoles resonate at only a single frequency and thus reflect, or reradiate, at that frequency the belt is effectively transparent (non-reflective) at other frequencies. This is an important consideration for radio astronomers and for communications with space probes.

Analysis indicates that the orbital belt will cut intensity of light from stars by only one part in 10 billion, while radio signals from stars will be reduced by less than one part in a million at the dipole resonant frequency, far less at other frequencies.

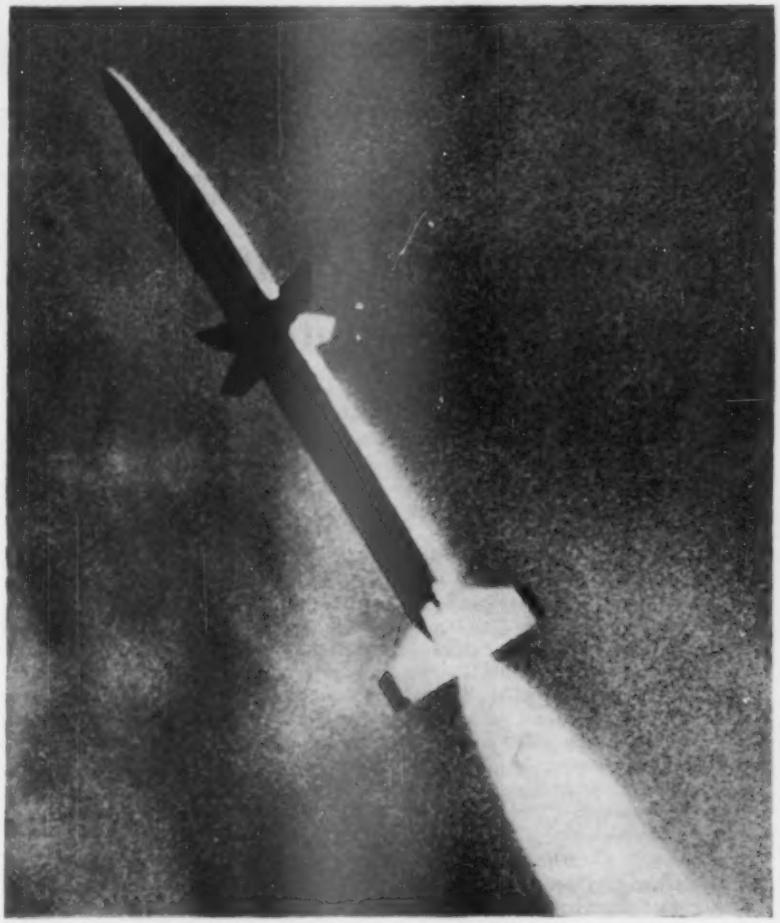
A pound of tiny dipole whiskers in orbit can provide as much effective signal reflecting area as approximately 1,000 lb. of material in the form of a conventional hollow-sphere passive communications satellite, Morrow contended. This gives the new technique a 1,000 to one weight advantage in terms of payload.

Computer studies made on the effect of solar radiation pressure acting on the low-mass dipoles indicate that orbital perturbations may be about 60 to 120 mi. If all dipoles had the same orientation in orbit, the effect on the belt would not affect its usefulness. But because the dipoles will have random orientation, the solar-caused perturbation will result in changes of dipole density within the belt.

How such random transverse dispersion within the belt will effect its lifetime is now under study. Present indications are that the greater part of the belt dispersion in a radial direction (thickness) will occur within the first 60 days, amounting to about 2½ mi. Dispersion is estimated at 60 mi. after a year.

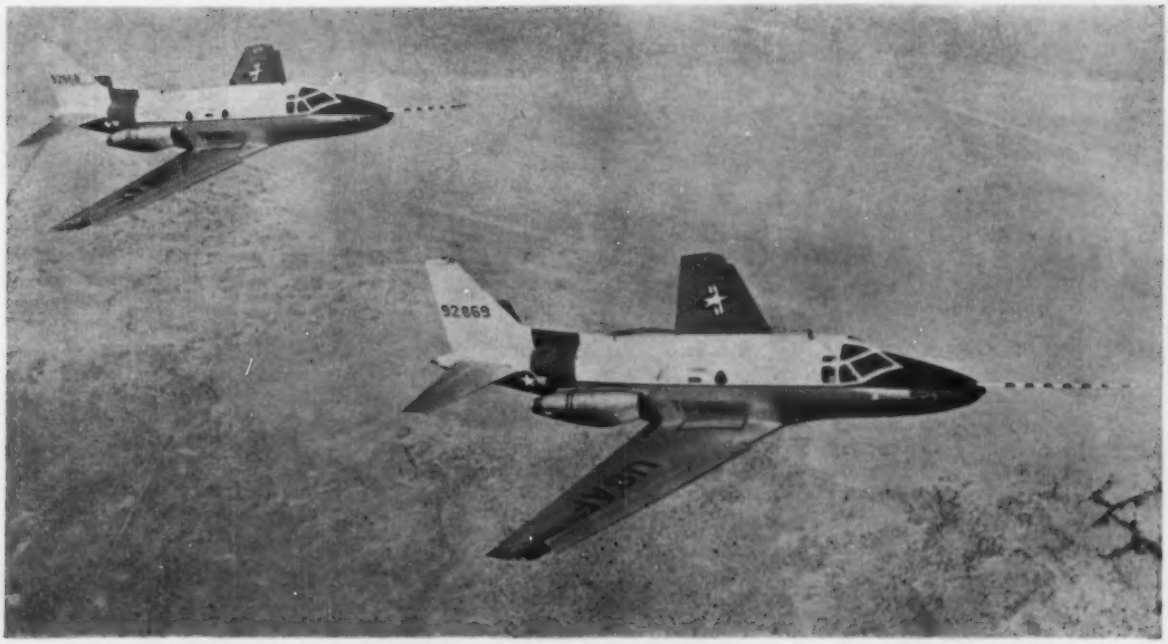
During this same time the belt orbit will undergo perturbations which are expected to be substantially greater than its dispersion. These will be principally a cyclic variation in orbit eccentricity, with a period of several months. For certain orbits the perturbation is cumulative. For a belt in polar orbit at an altitude of about 2,300 mi., the perigee is expected to be forced into the atmosphere after about 12 to 20 months. Longer lifetimes can be obtained at higher altitudes.

Morrow said that self-eliminating dipoles, which would remove the dipoles from space after their useful life has expired, are being investigated. Most promising technique, he indicated, is to take the dipoles from a white tin alloy, instead of copper as at present. Dipoles would turn to gray tin dust from the cumulative effect of low temperatures experienced when in the earth's shadow. Solar radiation pressure would cause this tin dust to re-enter the earth's atmosphere. Time required for the dipoles to turn to dust would be controlled by suitable alloying of the tin, Morrow claimed.



British Develop Blue Water Missile

Blue Water medium-range surface-to-surface missile is being developed for the British Army by English Electric Aviation, Ltd. Solid-propellant missile, incorporating an inertial guidance system to minimize effectiveness of electronic countermeasures, is 25 ft. long and has a maximum diameter of 2 ft. Control surface span is 6 ft., 9 in.; fin span 6 ft., 5 in. Missile is being developed to reduce British army's dependence on the U. S.-built Corporal medium-range weapon.



North American Flies First Two Production Sabreliners

First two production models of North American's T-39 twin-jet Sabreliners join up for a test flight near Palmdale, Calif. No. 1 Sabreliner (AW May 16, p. 109) shown in foreground had just completed 1,820-mi. flight. U.S. Air Force has ordered 94 Sabreliners. Powerplants are two Pratt & Whitney J60 turbojets (JT12s).

Rise in Turbine Aircraft Leads FAA to Revise Maintenance Rules

Millville, N. J.—Increasing importance of the turbine engine and resulting complexity of business and executive aircraft was underscored last week by Federal Aviation Agency in a move to drastically revise its progressive maintenance rules.

Overhauling the rules will result in a new package of inspection and overhaul time limitations to replace the present period inspection limits, according to Charles Schuck, chief of FAA's general aviation maintenance branch, who spoke here at Airwork Corp's annual Operations Symposium.

In effect, the new rules follow accepted airline practices of continuous maintenance, Schuck pointed out. He figures the rules will be completed within two years—applied initially to the Grumman Gulfstream turboprop and Lockheed JetStar—after a widespread investigation within the industry.

Schuck said FAA first will set up a maintenance review board to work with operators and manufacturers to set up the new time limitations. General aviation will participate through draft releases, under the provisions of the Administrative Procedures Act.

Schuck's statement that FAA would overhaul its maintenance rules was greeted with intense interest by some 400 attendees, all of whom are in some way concerned with this phase of government control.

Schuck noted that FAA is aware of the limitations of the periodic inspection which was "designed to handle relatively simple aircraft" whose utilization seldom was more than 100-200 hr. per year. But the national average is up to 684 hr. utilization annually and is still going up.

"The fact that the authorized inspector is personally accountable for the complete period inspection prevents other persons from conducting the inspection under his supervision," Schuck said. "This imposes a difficult, if not impossible, task on these individuals as the size and complexity of the aircraft and its systems increase."

In contrast, he noted, the certificated repair station can assign mechanics because of an inspection system that allows delegation of responsibilities within their own organizations, and the organizations are held responsible by the FAA for action of their mechanics. In the case of single-ownership, operating rules have made the owner responsible for the airworthiness of his plane and seeing that his aircraft was made available for required inspections and necessary maintenance.

To combat this, FAA established the progressive system of maintenance in 1956, a basic concept that had been employed by airlines for years to reduce downtime. But, Schuck pointed out, the progressive system lacks a prescribed schedule for inspection and maintenance of specific aircraft, "a lack particularly significant in the case of the large aircraft with more complex systems, and even more significant in the case of turbine-power, high-performance aircraft."

Development and administration of future maintenance standards, he said, must recognize these facts:

- **Number of business** and executive operators and aircraft far surpass the number of airlines, whereas the number of aircraft per operator is considerably less than an airline.
- **Economic factors** affecting business operators against those of the airlines.
- **Utilization of individual aircraft.**

Keeping these points in mind, he continued, FAA is considering development of a continuous maintenance system to refine provisions of the current progressive maintenance inspection system and eliminate the need for the periodic inspection.

Proposal will prescribe specific time limitations for inspection and overhaul and, where applicable, retirement of parts. Initial times, Schuck explained, will be based on the best available in-

formation from the manufacturers, the operators and through research by FAA.

Under the Administrative Procedures Act, FAA must publish any proposals for rules changes in the Federal Register for comment and for adoption. A notice of from 30 to 90 days usually is provided for industry study and comment.

Schuck stressed that the new regulations will apply equally to all general aviation operators of a particular make and model of aircraft, and revised time limitations will be published when operating experience warrants. FAA will monitor each operator's program to assure that initial time limitations are observed.

Monitoring also will show whether increases or decreases in the limitation are consistent with the operator's particular reliability experience, Schuck explained. Reliability, he pointed out, will be judged on unscheduled equipment removals, flight interruptions, malfunctions as well as other defects.

"This phase requires considerable study and development of reliability factors," Schuck said. "You, of course, will be required to keep a maintenance history to substantiate the program you are following."

The new rulemaking, Schuck said, is accentuated by FAA's duty toward public safety, but has not been premised solely on accident records or statistics "nor do we intend to wait for such activity to guide our actions."

He added: "While the majority of executive aircraft operators continue to record their maintenance programs as consistent with our period inspection provisions, our surveillance reveals that these aircraft are, in fact, maintained by following a form of progressive or continuous maintenance system.

"This, in itself, emphasizes the need for a more realistic maintenance rule than is presently provided in Civil Air Regulations."

Soviet Automatic Control Work Impresses Visiting U.S. Scientists

Cambridge, Mass.—Breadth and magnitude of the Soviet Union's effort in automatic control and the top-level support that the government gives to this effort impressed U.S. scientists who attended the recent International Federation of Automatic Control (IFAC) Congress in Moscow.

Six American scientists who attended the congress told the Joint Automatic Control Conference here that papers by Soviet scientists were particularly strong in control theory and analysis, and said there was great emphasis on adaptive or self-optimizing systems.

American scientists conclude that Soviet control theory is abreast of that in the U.S. and other major Western countries, perhaps more advanced in certain areas. But some visitors saw evidence that the Russians have been slower in converting this theory into industrial applications.

Approximately half of the nearly 300 technical papers presented in Moscow by representatives of 29 countries were devoted to control theory. Of these, about 60% were devoted to self-optimizing or adaptive control systems, according to Prof. John G. Truxal of the Polytechnic Institute of Brooklyn. Remainder of the theory papers were devoted to non-linear systems and multiple-dimension systems.

Soviet scientists reported on an experimental self-optimizing system which automatically adjusts as many as 12 variables simultaneously. Truxal noted that the Russians prefer to start with general theory, then apply it to specific applications while the usual approach in the U.S. is just the reverse. He also noted that the Soviets place great emphasis on statistical techniques of analysis.

Joel Hougen of Monsanto Chemical Corp. also noted great emphasis on theory in Soviet papers on control components, and added that the theory appears to be "excellent." But Hougen observed that although the Russians appear to have studied many components and systems in the laboratory, "it is not clear that their practicality has been evaluated."

Hougen also commented on the lack of reference in Soviet papers to specific industrial applications of the techniques or systems reported. There were no references in any Soviet papers to military applications.

Dr. John E. Gibson of Purdue University also saw evidence that the Russians have not fully bridged the gap between their control theories and industrial uses. But he said that the Russians recently have established five new institutes which are intended to speed the application of automation to basic Soviet industries. One of these at Kiev now employs 2,000 persons and the figure is expected to triple in several years, U.S. visitors were told.

Past IFAC President Harold Chestnut of General Electric Co. told AVIATION WEEK that his visits to several Soviet industrial facilities and institutes during the trip did not show the Russians to be backward in applying automatic control technology.

In fact, Chestnut said, several Russian scientists expressed surprise that the U.S. had not yet made wider use of self-optimizing systems in its industry. Initial U.S. application was to automatic pilots for aircraft and missiles.

Chestnut says that Russian machine tool control systems do not appear to be so sophisticated as some in use in the U.S. Dr. Gibson also observed that the Russians appear to lag behind the U.S. in the use of digital control techniques.

Soviet scientists, many of whom speak English, are well versed on new American developments in automatic control, largely as a result of the Soviet's massive program of translation of all important foreign technical journals.

American visitors also reported that Soviet scientists had put much more time and effort into preparing for the IFAC congress than their U.S. counterparts. Preprints of the papers were made available in advance, but translation delays resulted in American delegates receiving their English language versions only a few days before leaving for Moscow.

Soviet scientists were prepared with penetrating questions following the technical papers. These were directed at Soviet speakers as well as visitors.

The Russians were extremely cordial and hospitable in relations with American scientists, despite the fact that the congress was held shortly after the U-2 incident and the blow-up of the Summit meeting.

Prof. Truxal and Dr. Gibson saw indications that the Russians may not be making the best use of their young scientists because Soviet research is directed by members of the Academy of Science, nearly all of whom are men in their fifties or sixties.

Men of such advanced years may become enamoured with research problems that are no longer important and force younger scientists into research areas which are less promising and interesting to the younger men, Truxal suggested.

John Lozier of Bell Telephone Laboratories said that Soviet scientists appeared much more confident of their position relative to Western scientists than a few years ago. He attributes this to the Soviet's Sputnik I and subsequent Russian space achievements.

The Joint Automatic Control Conference here at the Massachusetts Institute of Technology was sponsored by the American Society of Mechanical Engineers, with participation by the Institute of Radio Engineers, American Institute of Electrical Engineers, Instrument Society of America and the American Institute of Chemical Engineers.

Bell Readies Liquid Fluorine Engine Bid

By Michael Yaffee

Buffalo, N. Y.—Bell Aerosystems Co. is readying a proposal for the Air Force on a liquid fluorine rocket engine designed for use in an upper stage of an advanced satellite carrrier vehicle.

Engine will use hydrazine as the fuel and will produce approximately 15,000-lb. thrust. Propellant will be fed by turbopumps into a regeneratively cooled aluminum thrust chamber. Throat and exit nozzle of the engine also will be fabricated from aluminum drilled with coolant passageways. The new engine is expected to have restart capability similar to that of Bell's present Agena model.

Major attraction of the new engine, according to Bell spokesmen, is that it will offer a 50% increase in performance over a liquid oxygen-liquid hydrogen engine of the Centaur type in the same size class, owing to the high bulk specific gravity of the liquid fluorine-hydrazine propellant mixture.

The new engine, says Bell, could be produced within 18 months after receipt of contract, a time period expected to be within the period specified in the anticipated Air Force request for proposals on an advanced upper stage rocket engine.

Rocketdyne reports its complete upper-stage fluorine system, called the Nomad, has been test-fired in "flight-weight hardware" and could be proposed for any program that may develop in this line. In the 15,000-lb.-thrust class, the Nomad was developed as a pressure-fed system; but Rocketdyne says it can offer the engine with a turbo-prop feed system.

Bell, which has been working on liquid fluorine engines for the past four years under Air Force and National Aeronautics and Space Administration contracts, disclosed that it has been static-firing full-scale prototype fluorine engines for the last year at USAF Plant 38 in Modeltown, N. Y., using hydrogen, hydrazine and ammonia as fuels. In some cases, the engines have been fired into an aspirator duct to simulate altitude and, in others, simply fired into the air. The exhaust products, including the highly toxic hydrogen fluoride, dissipate rapidly, creating no hazardous situations, according to Bell scientists.

At the present time, Bell is still carrying out work on its fluorine engine under an NASA contract and is negotiating with Air Force for a new research and development contract that would permit it, among other things, to investigate the use of a hydrazine gas generator to drive the turbine for the propellant pumps.

In its work to date, when Bell has fired the engine with fluorine and hydrogen, the hydrogen has been used to cool the thrust chamber and drive the turbopumps. Combustion chamber pressure in these runs has been approximately 300 psi. When the runs were made with hydrazine and fluorine, the propellants were pressure-fed into the chamber, and combustion chamber pressure was approximately 200 psi. The hydrazine was used to cool the thrust chamber, doing a satisfactory job, says Bell.

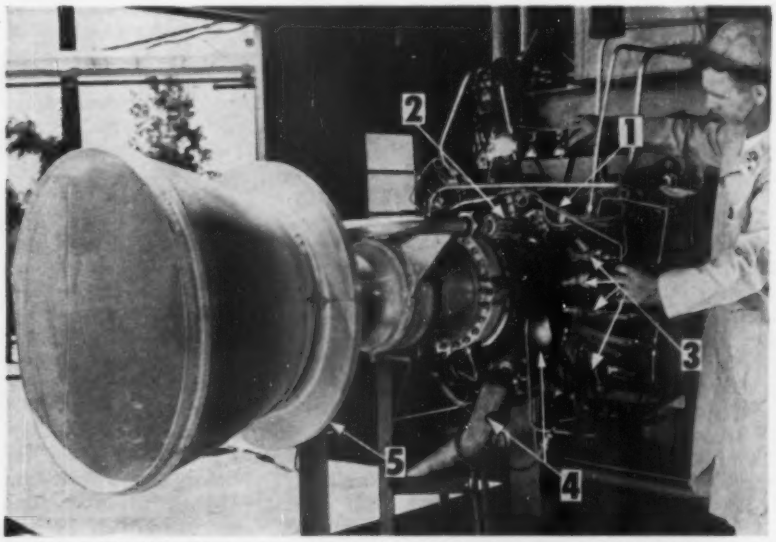
The thrust chamber could be made out of steel or nickel alloys, according to Bell engineers, but they feel that the drilled aluminum structure they currently are using is more than adequate. Without coatings or inserts in any part of the thrust chamber, the engines have served satisfactorily through repeated firings. Bell uses a nickel injector through which the propellants are sprayed into the combustion chamber.

Biggest problems encountered in their fluorine engine work, according to Bell scientists, were the development of satisfactory sealing arrangements on the fluorine pump and learning to pump liquid hydrogen without it having to boil off. The first problem was solved, says Bell, through a modification of the sealing arrangement on the company's Agena pump. The present fluorine pump seals consist of an aluminum oxide surface against an aluminum oxide, and carbon against aluminum oxide. The seals, a Bell engineer reports, are efficient even after 30 min. of operation.

There is no lubrication problem with the pumps, the company says. The gear box is isolated from the cryogenic propellants by a pin arrangement. Pumping the fluorine proved to be no problem because the fluorine can be subcooled with liquid nitrogen. Preventing liquid hydrogen from boiling off and avoiding cavitation was a different story. Bell claims, however, that it has now solved this problem.

Owing to the hypergolic nature of fluorine systems, Bell expects no trouble in providing the engine with restart capability at altitude. Initial restart system probably will be like that on the Agena. Sequencing unit or relay box used in the new engine has been borrowed from the Agena design. Starting sequence is as follows: the turbine is started; pumps are brought up to pressure; propellant line valves are opened, giving almost simultaneous entry of fuel and oxidizer into thrust chamber; thrust chamber is brought up to pressure within specified time. Restart sequence would be the same, says Bell.

In the opening of the propellant line valves and entry of fuel and oxidizer into the combustion chamber, Bell reports that it has experienced fluorine leads and lags up to 150 milliseconds with no accompanying problems.



LIQUID FLUORINE rocket engine developed by Bell Aerosystems is in 15,000-lb. thrust class. Above, the engine is being set up for firing with liquid hydrogen. In picture can be seen (1) thrust chamber propellant valve, (2) hydrogen feed line, (3) instrumentation pick-ups, (4) turbine exhaust attachment and duct, and (5) aspirator adapter ring. Combustion chamber, throat and exhaust nozzle are fabricated from aluminum.

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MEMO TO JOHN:

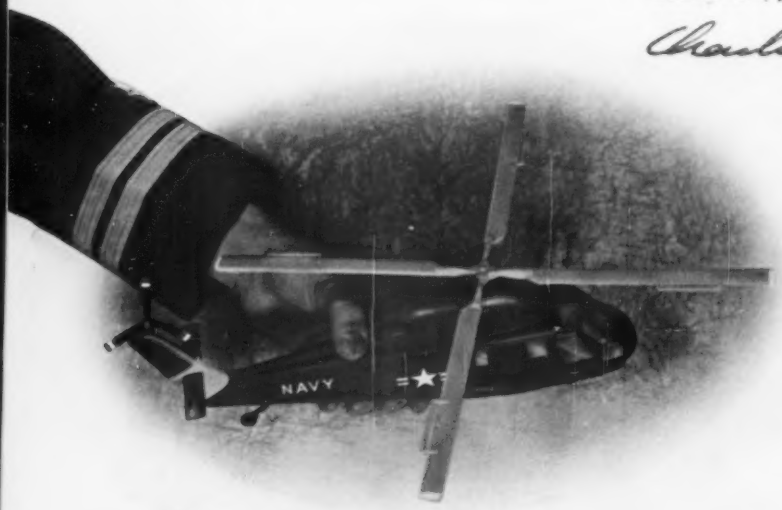
Thank you for your letter in which you express your preference for Kaman helicopters. As you put it:

TRRFFIC IN HEIICOPTERS. YOUR That is the truth. It sure is ~~that~~ ~~is~~ the truth.

Everyone here at Kaman Aircraft is proud of the helicopters and aircraft we build and supply to various branches of our Armed Forces. It makes us doubly proud when boys like you write and tell us what you think. We know that you realize that our whole National Defense program is one sure way of guaranteeing that you and your friends will get the chance to grow up and become terrific doctors or lawyers or scientists... maybe even terrific helicopter pilots.

Sincerely,

Charles H Kaman



...in National Defense **KAMAN** is part of the plan

**Facsimile of a letter to the company

Balloon-Borne Satellite Detector Studied

Pasadena, Calif.—A new method of detecting unannounced satellites with high-altitude balloon-borne optical systems is now under development for the Geophysics Research Directorate, Air Force Cambridge Research Laboratory, by Electro-Optical Systems, Inc., and a prototype system is expected to fly next summer.

The balloon-borne telescope will have a telemetry link to the ground with protection against electronic countermeasures and 360-deg. hemispherical coverage. Electro-Optical Systems scientists emphasize that it is not a tracking device. It is intended to scan the sky and acquire a satellite that has not been previously announced or on which no tracking information is available.

Electro-Optical officials say the system can be used to detect nuclear bomb-bearing satellites or unfriendly reconnaissance or communications vehicles. With some modifications the unit might also be used for ballistic missile early warning.

Heart of the system is a 20-in. modified Bouwers telescope suspended from a 200-ft.-dia. Air Force balloon at altitudes of approximately 20 mi. At this height, solar radiation reflected from unannounced satellites can be detected over ranges of several hundred miles. Vector and position information of the acquired satellites will be telemetered to ground readout stations.

The telescope and its electronic package will weigh about 1,000 lb., will be suspended by a 300-ft. cable from the underside of the balloon, and will sweep the sky at elevation angles between 15 and 75 deg. As the unit continuously rotates 360 deg., almost complete hemispherical coverage is provided.

An economic advantage over satellite-borne detection systems is the elimination of expensive booster rockets. Additionally, the balloon-borne system can be returned to earth by parachute for necessary repairs, adjustments or reassignments.

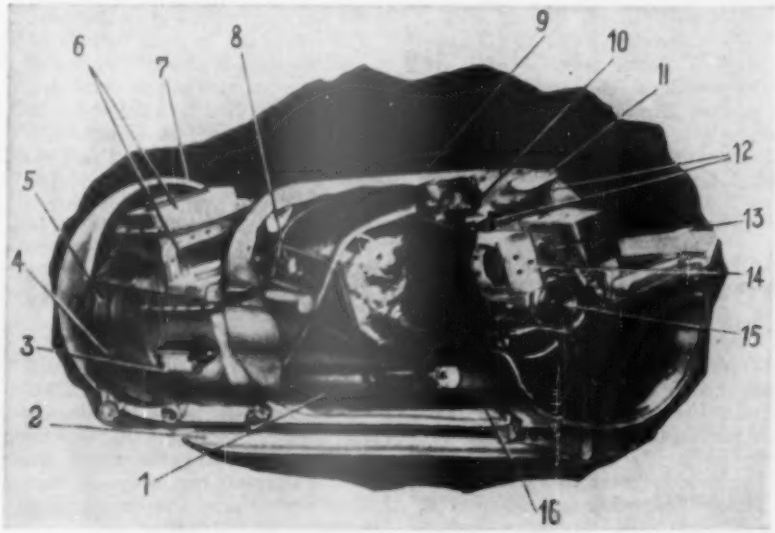
A complete detection system would employ a series of balloon-borne telescopes placed at predetermined areas to provide satellite detection over a desired region. Deployment of the system to all parts of the world would provide the necessary 24-hr. illumination for around-the-clock surveillance.

Design of the specially modified Bouwers telescope will emphasize simplicity, immunity to temperature extremes, and high accuracy. Elements of the telescope will include two corrector plates or lenses, a spherical mirror and a detector mosaic.

Radiation entering the telescope passes through the first or aspheric corrector plate, and then through the second lens with concentric spherical surfaces. The radiation finally strikes a spherical mirror which focuses the light upon a detector mosaic supported on the rear of the second corrector plate.

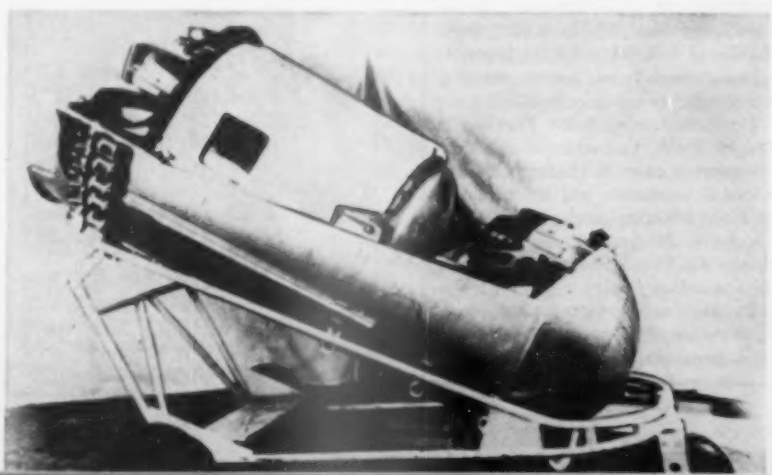
The detector mosaic was adapted to meet problems of background scattered radiation, the available reflected radiation from the satellite, the signal-to-noise ratio of the best detector cells available, scanning rates, and many other factors. A pattern of 56 individual detectors was selected as a compromise between cost and range. Each cell will consist of a hemispherical strontium titanite lens onto which a lead sulphide detector is attached. Diameter of each lens is 2 mm. and the width of the lead sulphide deposit is about $\frac{1}{16}$ mm.

Radiation detected by each individual cell will be channeled to a miniaturized preamplifier and discrimination device.



Soviets Detail Sputnik V Dog Cabin

Details of Soviet Union's Sputnik V, which successfully orbited and returned two dogs to earth (AW Aug. 29, p. 28), are shown in these Russian drawings (see p. 73). Above is the air-tight cabin which housed the animals, showing (1) air supply cylinder (2) capsule ejector mechanism (3) radio direction finding unit (4) battery for heating test tubes containing various microbes (5) accumulator battery (6) units of special scientific apparatus (7) ejector capsule (8) gage to measure cabin movements (9) air-tight cabin (10) microphone (11) RDF antenna (12) intake and exhaust valves (13) television camera (14) mirror (15) ventilation system (16) automatic device for combined feeding of the dogs. Sputnik V weighed 10,120 lb. and attained a near-circular orbit with a perigee of 190 mi. and apogee of 210 mi. Cabin re-entered on the 18th pass.



**Facsimile of a letter to the company

preamplifier and discrimination device, which decides by statistical analysis whether the output of the cell was due to noise or due to actual radiation. Once this decision has been made, an output on-off type signal will be turned on.

The outputs of all 56 discrimination circuits are sampled by an electronic commutator at the rate of 50,000 per second. The output signal telemetered to ground will have the form of an irregular train of pulses if discriminator had or had not detected a signal. After each discriminator is sampled, it is turned off and that discriminator is again ready to analyze the output of the corresponding detector.

The resultant train of pulses, together with azimuth, elevation and other data, is telemetered to the ground station where it is decoded and fed to the scope display. A slotted hemispherical sun finder provides a reference from which to measure azimuth. The three-legged landing gear is rotated counter to the telescope assembly to eliminate uncontrolled directional oscillations. A set of three flyweights serve the same purpose in the vertical plane.

Ground support equipment for the satellite detector will consist of a display system resembling a conventional radar PPI scope and tape recording equipment for storing telemetered data. The scope display will show the azimuth and the elevation data of any radiation source detected by the equipment.

Pips which occur at the same azimuth and elevation, sweep after sweep, can be identified as fixed stars detected by the device. Pips which appear to move across the face of the PPI at each successive sweep, following a definite pattern, represent satellites. Sometimes pips would occur randomly both in position and time because of the small, predictable, rate of false alarm signals put out by discrimination circuits due to the statistical nature of its decisions.

The system can be made entirely automatic by the addition of a computer in which is recorded astronomical data concerning the fixed stars detectable by the telescope as well as of previously launched, known satellites. This computer would compare detected data with known data and will tell when a new satellite has been observed.

New Towed Sonar Being Developed

Washington—Design studies for a helicopter-towed sonar vehicle incorporating higher speed capability and reduced self generated noise will be translated into prototype hardware early next year.

The project, sponsored by the Bureau of Naval Weapons, is a joint effort of the Convair and Stromberg-Carlson divisions of General Dynamics Corp. A team varying from 10 to 15 engineers from both divisions is doing the work at San Diego's Convair plant. Contract is for $500,000.

Under present Navy operational procedures, dipping sonar bodies are either held stationary in the water or towed at low speeds. Eight knots is the maximum possible now, using the Sikorsky HSS-1 aircraft.

In order to increase the search rate to sweep a greater area, a hydrodynamically designed body will be necessary. Coupled with greater speed, design will have to keep water flow noise to a minimum, not only around the shape itself but also the towing cable. To a lesser extent noise from the helicopter translated into the water must be considered and decreased.

In developing an optimum design, data obtained from the Navy's David Taylor Model Basin at Carderock, Md., and Convair's own towing tank are being used. At the higher speeds specified, cavitation, or the creation of partial vacuum in the wake, and turbulent flow generate the most noise. Next is the cable. Solutions could incorporate a sandwich or honeycomb structure, or perhaps a type of water boundary layer control. For the cable, fairing will be used to enable smoother flow around it and a trap in the cable itself will interrupt noise flow from the helicopter.

Provisions for housing the transducer must also be considered—thus a compromise between hydrodynamics and the package will result.

The shape will have tail surfaces and wings and in general will utilize knowledge gained in designing high speed submarines. When it becomes operational, the towed sonar will gradually supplant sonobuoys, which are dropped from aircraft and transmit received noise signals, or transmit signals received from active pinging or explosions as in the Julie system.

Apollo Conference Attracts 88 Firms

Washington—Conference for prospective bidders on feasibility studies for Project Apollo manned satellite system (AW Sept. 12, p. 38) attracted 200 representatives from 88 firms last week. Number is believed to be the largest to express interest in any government project, certainly in the space field.

Conference was held Tuesday at Langley Field, Va., after one-day postponement because of Hurricane Donna. National Aeronautics and Space Administration's briefing team consisted of Charles J. Donlan, Maxine A. Faget, Robert O. Piland and Glen Bailey of the Space Task Group.

Proposals are due Oct. 10, and two or three contracts will be awarded Nov. 15 for concurrent six-month studies.

House Unit Begins Intelligence Probe

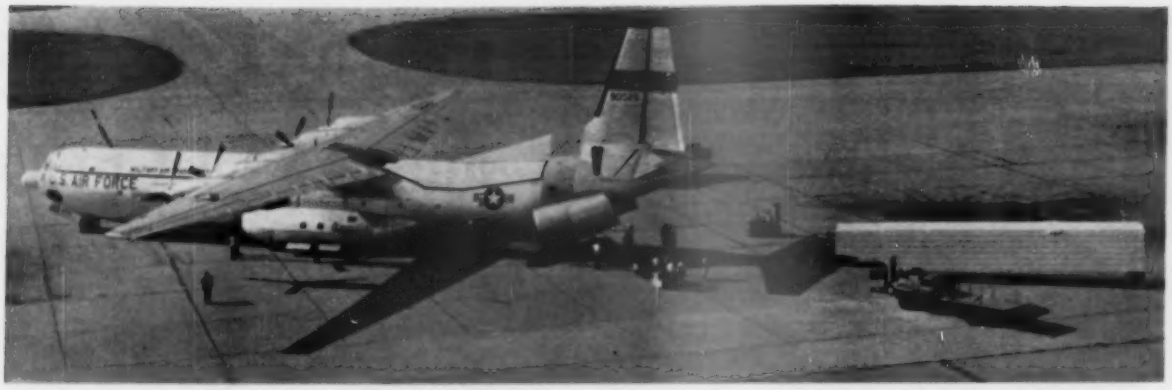
Washington—A special House Armed Services Subcommittee headed by Rep. Paul Kilday (D.-Tex.) last week launched a comprehensive investigation of the intelligence procedures and operations of Department of Defense, the military services, and Central Intelligence Agency with J. Vincent Burke, Defense general counsel, as the first witness.

At the outset, the subcommittee will deal with the specific defection case of Bernon F. Mitchell and William H. Martin, former National Security Agency mathematicians, who presented details on NASA monitoring of intelligence flights and NASA organization at a Moscow press conference (AW Sept. 12, p. 37). Robert Smart, subcommittee counsel, said that one objective would be to determine whether the defectors had advance information on the Lockheed U-2 reconnaissance flight that was downed near Sverdlovsk, Russia, last May 1. Later, the subcommittee will consider military and CIA intelligence activities in general.

Defense Department last week began its own special investigation of the Mitchell-Martin defection under Burke's direction with Lt. Gen. Joseph E. Carroll, Inspector General of the Air Force, as technical adviser.

Electra Hits Dike

New York—An American Airlines Lockheed Electra turboprop crashed and burned at La Guardia Airport last week when its left wing dropped on approach to Runway 31 and the left gear hit a dike, cartwheeling the aircraft. All 72 passengers and crew of four were evacuated. The transport was completing a flight from Boston in good weather when it hit the dike at the approach end of Runway 31. The runway in effect has been shortened to 4,900 ft. as a result of construction work at the field, and pilots tend to come in lower over the dike than formerly. At the Electra's controls when it hit the dike, according to American, was a supervisory pilot, Capt. Sheldon Pangburn, who had been checking out the flight engineer. Trans World Airlines pilots recently circulated a questionnaire to determine whether recommendations to restrict La Guardia operation should be made by Air Line Pilots Assn. (AW Aug. 8, p. 43.)



Minuteman Transporter-Erector Container Loaded on Douglas C-133B

First transporter-erector container for the Air Force Minuteman ICBM (AW Sept. 5, p. 56), is loaded aboard a Douglas C-133B at Wichita, Kan. Designed to transport missiles from assembly plant to launch areas, the unit, built by Cessna Aircraft Co., will undergo emplacement cycling tests after being fitted with its Bendix Pacific Division erection system and General Motors undercarriage.

Tiros I Discovery May Aid Forecasting

Washington—Tiros I experimental weather satellite has discovered that individual storm types have distinct cloud vortex characteristics which could provide the basis for a new and accurate forecasting technique.

In a summary of Tiros findings, Dr. Morris Tepper, chief of meteorological satellite programs for the National Aeronautics and Space Administration, said a catalogue of cloud vortex signatures could be used to forecast storm stages and behavior.

Tiros, launched last Apr. 1, was the first in a family of meteorological orbiters which will include Nimbus and Aeros. Tiros was considered a feasibility test, but it provided scientists with an unprecedented opportunity to study cloud cover with 22,952 photographs taken on 1,135 orbits over a 78-day period.

Tepper told a meeting of the Washington section of the Institute of Aerospace Sciences, that Tiros' discoveries included a description of a bright, four-sided cloud which later spawned into several tornadoes that hit parts of Oklahoma and Texas.

Tepper said 60% of the Tiros photographs are remarkably clear, but difficulty in fast analysis resulted from snow and ice backgrounds, sun glitter and orientation. Last problem was traced to an over-sensitive horizon system which confused clouds and land areas with the horizon. Magnetic dipole will be installed on Tiros II, with ground control of the spin axis.

More advanced systems, Tepper said, will include provisions for real-time transmissions from Ft. Monmouth, N. J., and Pacific Missile Range receiving stations to Weather Bureau analysts; onboard computers to sense selected cloud systems for photography, and improved sensory and transmission instruments.

Two more Tiros satellites will be flown, one before the end of this year and one next year. Polar orbiting Nimbus vehicles will follow on a six-month launch schedule, and Aeros is planned as a later stationary orbiter at 22,300 mi.

News Digest

Thompson Ramo Wooldridge feels its aircraft business shakedown is over. With quarterly aircraft volume now running $20 million, the company expects this business will continue to make a multi-million dollar contribution to over-all volume. Spares business is a steady long term source of sales, Chairman J. D. Wright told a meeting of investment men in New York last week, and TRW's aircraft business may show modest growth in the future.

Skybolt Meetings

Washington—Anglo-American conference on Skybolt air-launched ballistic missile was begun last week at Douglas Aircraft Co.'s Culver City, Calif., plant, where development engineering inspection mockups were displayed. Follow-up conference was held at Wright Air Development Division's Weapon System Project Office to discuss basic rules for integration of Skybolt into the RAF's Vulcan bomber force. Included in the discussion were details of work areas to be performed by the British, together with pricing details.

The RAF intends to carry out its own carry and drop development programs for the Skybolt, involving separation and free fall aspects of the missile. Live fire tests with Vulcans will be conducted from Eglin AFB.

Belgians decided not to cancel an order for Lockheed F-104s (AW Aug. 15, p. 28) and a decision is expected shortly on share of Belgian financing and U. S. weapons aid funds. SABCA currently is reproducing F-104 tooling.

Aeronutronic Division of Ford Motor Co. is studying structure of a three-man space vehicle for extended orbital periods at various altitudes. Study contract was awarded by USAF's Wright Air Development Division.

Arrangements were being completed last week for acquisition of Space Electronics Corp., Glendale, Calif., by Aerojet-General Corp., Azusa, Calif. Eighty per cent of SPEC's stock is owned by Pacific Automation Products Co., Glendale, Calif.

First Polaris fired from the second fleet ballistic missile submarine USS Patrick Henry off Cape Canaveral, Fla., ran wild and broke up on hitting the water 2,000 yards from the launch position last week. Navy said the malfunction was in a test device and will have no effect on the operational missile.

Lockheed and USAF are working on a leasing arrangement for an Electra to be used at Pacific Missile Range. Plane will carry special markings. The Electra was one of a Capital Airlines order of five aircraft. Lockheed is negotiating with a South American carrier for the sale of the other four Electras of the original Capital order.

Re-entry capsule of Air Force's Discoverer XV satellite vehicle, launched from Vandenberg AFB in a north-south orbit with a 472-mi. apogee and a 130-mi. perigee, was parachuted into the Pacific Ocean about 1,000 mi. southwest of the planned impact area near Hawaii and was located by searchers.

Small Airlines Rebel Against IATA Chiefs

Executive committee put down revolt in Copenhagen but some members may lose posts at next session.

By L. L. Doty

Copenhagen—Prospects that executive control of International Air Transport Assn. will undergo substantial changes during the next two years grew strong last week as the sixteenth annual general meeting erupted into an open rebellion by small airlines against domination of IATA's director general and the powerful executive committee.

Although the current executive committee lost none of its control during the four-day session and was able to quash the revolt with parliamentary technicalities, enough strength was mustered by dissident airlines to forecast some success in unseating at least a few of the committee's major airline members at next year's annual meeting in Sydney.

Revolt this year, which gained its momentum on three specific issues, served as a warning that unless significant changes are made in the executive committee structure, some members are ready to withdraw from IATA.

Charges that small airlines are denied membership on the executive committee because of undemocratic nominating processes led to an uprising by small airlines. At the present time, the executive committee nominates its own members prior to the annual meeting, making the group virtually self perpetuating. Demands that nominations be made from the floor during the annual meeting were countered by assurances that nominations will be accepted by mail for consideration before the next general assembly convenes. It was the first time in IATA history that makeup of the executive committee has been challenged openly on the assembly floor of a general meeting.

Other issues which drew fire from the delegation included the forced resignation of John Brancker as IATA traffic director. A proposal to raise maximum fines for infraction of IATA rules drew sharp opposition and Seaboard & Western fought the resolution denying all-cargo carriers the right to vote on passenger rates within the Traffic Conference and demanded an early hearing before the executive committee.

Privately, small carriers here contended that strength of large carriers in controlling the executive committee is determined by the amount of membership assessment they pay each year in relation to amounts paid by smaller carriers. Out of 18 members of the committee, six have been members since IATA was reformed in 1945. Of the six, five—Pan American, BOAC, Air France, KLM and SAS—pay out more in assessments annually than any of the remaining 74 members, with PanAm ranking first by a wide margin. The sixth—Qantas—is the 11th highest payer.

Of the remaining 12, five have been members for 11 or more years, three for seven or more years. Four relatively new members—Braniff, Japan, Middle East and Varig—are represented on the executive committee. All members of the committee are in the upper half of the total IATA membership with respect to amount of assessment paid each year.

In addition to objections to the executive committee, small carriers began to express bitter opposition to their failure to win some representation on the important Traffic Advisory Committee. They pointed out that of the 11 members of this group, 10 are currently members of the executive committee. IATA Director General Sir William Hildred drew criticism from the dissident group because of his close association and direct relationship with members of the current executive committee which, small carriers charged, could vest too much authority in one person.

Inability of delegates to reach agreement on a number of other issues and an executive committee decision to defer such issues as permanent chairman of the Traffic Conference to a later date underscored the discordant atmosphere throughout the four day session. During social events, conducted in a hospitable air, delegates appeared to gather in factional groups rather than to intermingle generally. Social activities were sharply curtailed as result of a ban on manufacturers who at previous meetings filled open times with luncheons.

The Brancker issue was raised at the first closed plenary session. The executive committee gave no reason for requesting Brancker to resign and several attempts were made to divert the floor discussion to the "overbooking" issue. The Brancker case was successfully dropped when the executive committee noted that the case was internal staff matter, not one for assembly debate.

Seaboard & Western's fight to have the executive committee reverse itself on its decision—recommended by the Traffic Advisory Committee—to separate voting on passenger and cargo rates was also brought on floor during the opening plenary session. Seaboard charged that the resolution was "disenfranchisement" of its rights as an active IATA member. When reminded by Hildred that the resolution has been approved by Civil Aeronautics Board, Seaboard said it had petitioned CAB for reconsideration and added that it wanted the subject brought up here as an IATA matter, not a U.S. government matter.

The airline demanded early hearing before the executive committee, which presumably will be granted.

Several attempts have been made in the past at further modifications of voting procedures in the Traffic Conference

SAS Bilateral Talks

Scandanavian countries, already agitated over U. S. threats to restrict Scandinavian Airlines System traffic capacity, were further embittered by failure of CAB Member G. Joseph Minetti to arrive here on time for bilateral talks which were scheduled to open last Monday. Minetti's delay postponed talks until Wednesday. Renegotiation of the bilateral air transport agreement is viewed here as an issue of national significance and U. S. failure to begin talks on schedule comes close to a diplomatic affront in the eyes of SAS officials.

In Washington, both CAB and State Department spokesmen indicated that it was understood by all parties that Minetti would not arrive in time for the first day of talks, because of last minute business pressures. Two Board delegates, understood to be prepared to present the Board's position, along with the state delegation departed on Sept. 9, while Minetti left at 6 p. m. on the 14th. Airline sources see the alleged Scandinavian displeasure as a harassing technique designed to weaken any U. S. move to limit SAS traffic in this country.

Congo Republic Operates Soviet-Built Il-14s

Soviet-produced Ilyushin Il-14 piston-engine transports bearing the markings of the Congo Republic are shown at Leopoldville. The Soviet Union presented the aircraft to Congo Premier Patrice Lumumba as a gift (AW Aug. 22, p. 50). They are flown by Soviet crews.

but widely divergent views on the subject among members have stalemated any proposals to revise voting procedures as a means of preventing conference deadlocks, such as that which broke up the Honolulu meeting last year.

Delegates Warned

On this point, the Traffic Advisory Committee warned delegates that it is "unlikely that further emergency conferences will be condoned and unless members reach complete agreement at the fall conference they will have no agreement at all." The committee added that if "irresponsible use of voting rights takes place" at traffic conferences, the traffic advisory committee will take "urgent corrective action."

On other issues, delegates agreed to an increase of enforcement officers from a total of eight to 22. Attempts to increase the maximum fine from $25,000 to $50,000 were voted down. One carrier proposed $100,000 as the ceiling.

Traffic Statistics

Chances now appear strong that some form of exchanging traffic statistics will be required within the next few years despite general IATA opposition to such a practice. However, International Civil Aviation Organization committee now is considering various recommendations for exchange of origin and destination figures and will soon offer its proposed system to the ICAO council and to IATA. Since the proposed system will have several variations, IATA may be forced to support one in order to safeguard itself against any plan which might be unsatisfactory and costly to member airlines. Plan most likely to win all-around approval is one proposed by U. S. which calls for worldwide collection of statistics by microfilming each tenth passenger coupon.

Noise Suppression Adds Millions To Airline Operating Expenses

By Robert H. Cook

Washington—Use of turbojet noise suppressors is currently costing jet operators more than $1.7 million a month in added operating expenses and these costs will increase as the airlines voluntarily transfer a major portion of jet training flights away from heavily populated areas.

Despite the burden of meeting this additional cost, trunklines are cooperating fully with the industry's National Aircraft Noise Abatement Council, which has been urging use of alternate training fields as the quickest and most practical means of partially reducing the noise problem around metropolitan areas.

In less than two months this joint NANAC-industry program has resulted in the removal of the majority of jet training flights from Los Angeles and a 50% frequency reduction in this training at San Francisco, each of which formerly had a frequency of 1,000 training flights a month.

Alternate fields with adequate runway lengths and ILS equipment, being used for Los Angeles area training flights are located 60 mi. away at Chico and 40 mi. away at Ontario. Jet training shifted from San Francisco is now conducted at Fresno, which is more than 125 mi. distant.

A similar transfer will be made soon for the Seattle, Wash., area from a selection of five alternate fields. Boeing Airplane Co. utilizes its own field in the nearby area, plus a second facility near Portland, Ore. NANAC is now completing surveys for additional transfers at Boston and Miami, major East Coast turnaround points, which have a heavy concentration of turbojet training.

Jet training flights in the vicinity of New York City have been conducted at the Republic Aviation Corp. field at Peconic, L. I., since the initial inauguration of turbojet service.

More Transfers Planned

While NANAC continues to urge more effort toward development of a basically quieter turbojet engine and community zoning restrictions to prevent residential construction in any noise-critical areas, it is particularly encouraged by airline cooperation in transferring training activities. The council is surveying every major terminal area where suitable alternate fields are available for further transfers.

Although the airlines affected by the transfers have not given cost breakdowns on the added expense, they obviously will be significant. Landing fees alone, customarily covered on a set annual price for both scheduled and training flights, now must be borne as an added expense at the alternate fields.

Costs which ordinarily would have mounted because of these transfers are inflated further because of the economic penalties levied by the use of noise suppressors, the airlines contend.

True magnitude of the cost of noise suppression measures taken so far may be judged by American Airlines' figures, which estimate that the use of noise suppressors has raised the monthly oper-

Boeing 727 Transport

Boeing has decided to retain the three-engine configuration for its 727 transport, with one engine mounted in a pod on each side of the tail, as in the Caravelle, and one mounted on a cantilever structure in the tailcone. The 135,000 lb. short-haul transport will use Pratt & Whitney turbofans or Rolls-Royce turbofans built under license by Allison Division of General Motors. Engine selection is being delayed while airlines decide which they prefer.

Full-scale working mockups of the 727 transport and some of its subsystems are nearing completion at the company's Renton, Wash. plant.

ating cost of each Boeing 707 transcontinental flight an estimated $10,000. American's final figure works out to $240,932.49 a month for a 24-plane operation, based on a 7½-hr. daily utilization rate.

Projecting this to 169 turbojet aircraft now being operated by 13 U.S. carriers, the annual cost to these airlines would exceed $20.4 million and would continue to climb as suppressor-equipped aircraft are added to the fleet.

Indirectly, the cost exceeds this figure to reflect nearly $50 million in research and development costs between both the airlines and manufacturers. Much of this cost also has been included in the final aircraft purchase prices. In addition, a high percentage of runway extensions and additions, at an average cost of $1,000 a foot, have been for the primary purpose of noise abatement, according to the Air Transport Assn.

American finds that suppressors have increased flying time by 4% and fuel consumption by 4% on short range flights. On long range flights, flying time is increased by 2% and fuel consumption by 9%. Generally the airline estimates that its total monthly bill attributable to noise suppressors for 24 aircraft increases level flight operating costs $180,690 and climb costs by $29,458. Payload loss due to the suppressor weight was calculated at $23,592 and payload loss due to the need for more fuel at $4,191, with an additional $2,000 a month for maintenance and repairs to the units.

Applying these estimates to its direct operating cost for the 707 of approximately $216.32 an hour for fuel and $679.52 an hour for other direct costs, American estimated an operating cost of $4,966,536 for suppressor-equipped turbojets as compared with $4,784,846 for aircraft not using suppressors.

With one minute added to the climb time to 30,000 ft., plus 500 additional pounds of fuel, the airline figured that the increased air drag induced by suppressors, plus the thrust loss, results in the jet fleet requiring 22.5 more hours of flight time in a 30-day period, plus an additional 100,970 gal. of fuel. Combined cost of the two items amounts to $29,458.

Payload displaced by the suppressor weight of 556 lb., the airline said, plus some loss from the increased fuel weight, is particularly applicable to New York to Los Angeles and San Francisco, along with Boston-to-Los Angeles flights, which alone generate 530,400 plane miles a month. Available ton miles lost to suppressor use over these routes amount to 147,451 mi., which at a minimum cargo rate of 16 cents per ton mile is estimated to be costing American $23,592 a month.

Beyond its increased operational costs, American points out that it has an additional investment of $8.1 million involved, covering development costs of the suppressors and increased costs due to several runway lengthening projects.

Southern Hits Snag on Losses

Washington—Southern Airways' recapture of operational losses from its current three-month old strike may hinge upon the outcome of a Civil Aeronautics Board rehearing, ordered by the U.S. Court of Appeals two years ago, after the Board rejected a similar Trans World Airlines subsidy claim.

Seven years ago the Board rejected a portion of subsidy requested by TWA on grounds that they constituted strike claims not qualified for payment under CAB's subsidy policy. The court order remanding the case for a new hearing said the Board had failed to determine whether the strike losses were recoverable under TWA's rate of return or if they amounted to a loss beyond the control of management.

While no date has yet been set for the TWA rehearing, Board attorneys feel that CAB's plans to put all local service airlines on final mail rates by the end of this year may spur a decision in the TWA case, which could then serve as a policy guide for settlement of the Southern issue.

As the situation now stands, Southern is on a temporary mail rate which provides a break-even earning plus an interest rate on investment. The amount of subsidy approved by the Board is based upon a mileage flown under normal operations. The difference between what Southern would normally collect in subsidy and the smaller sums now being allowed by CAB, because of the carrier's heavy cutback in service during the strike, will not become a distinct issue until the airline enters into negotiation with the Board over a final mail rate.

While Southern has continued to expand its strikebound operation to a point approaching normal, its June and July operations were less than a third of the usual service and business for the corresponding months of 1959.

The airline reported an operating loss totaling more than $358,000 for the two months, after allowable subsidy payments of $144,000. In the same two months last year Southern recorded a $19,000 operating gain after a combined subsidy allowance of $393,000.

Allowable subsidy paid the carrier for last month has not been computed but can be expected to total a great deal higher than it did during the first two months of the strike, on the basis of a strong service expansion.

Initial impact of the strike, called by 147 Air Line Pilots Assn. members on June 5, resulted in Southern's producing less than one third of its normal service for that month. Passenger originations were 22,743 in June, 1959, but dropped to only 7,567 for the same month this year. Available seat miles decreased in a similar ratio from the June, 1959, level of 10,041,000 mi., based on nearly 4,800 departures, to only 3,386,000 seat miles this June and less than 1,400 departure flights.

Little progress was made in July but Southern reports that the full force of a newly trained non-union pilot force employed since the strike began showed concrete results last month, producing 14,983 passengers as compared with the August, 1959, total of 16,885. Revenue passenger miles, which shrank to 1,364,000 in June, climbed to 2,718,000 mi. in August, approaching the normal 3,055,000 mi. recorded for the same month last year.

Pilot Boycott Averted

Washington—Possible shutdown of airline service to 24 southern cities was averted last week when airline attorneys won a temporary injunction against a threatened Air Line Pilots Assn., attempt to halt flights to any city served by Southern Airways, which has been strikebound by the pilots since June 5. Ruling by the U. S. District Court in Chicago was handed down one day prior to an ALPA boycott schedule which called for a blockade of three airports at a time, beginning on Sept. 15 and continuing through Oct. 6 until the 24 cities had been covered. Huntsville and Dothan, Ala., along with Baton Rouge, La., had been selected as the first group for blockade by the union.

Transatlantic Carriers See Cargo Surge

By David H. Hoffman

New York—Cargo carried across the North Atlantic by International Air Transport Assn. carriers will increase at least 40% during 1960 to continue the breakthrough trend begun last year when IATA freight flow grew a record 45%, an AVIATION WEEK survey indicates.

The traditional second-half upswing in IATA cargo traffic, when coupled with the traffic record for the first six months, is expected to produce a year-end total of about 56,000 tons. In 1959, the 17 IATA carriers operating along North Atlantic routes moved 40,027 tons.

Airline cargo experts report that these key factors are behind the continuing surge in transatlantic freight traffic growth:

- **Selective rate reductions** voted by IATA to take effect on Apr. 1, 1959, and Apr. 1, 1960.
- **Phase-in of piston-engine** freighter conversions, primarily the Douglas DC-7F and Lockheed 1649 and 1049 Super Constellations.
- **Inauguration of jet service** by 14 of the 17 IATA carriers during 1958, 1959 and 1960 (AW June 27, p. 43).
- **Vigorous new sales** emphasis on air cargo as over-all competition mounts in the North Atlantic passenger market.
- **European manufacturers'** drive to expand their sales in the United States without sinking much capital into costly warehouse distribution systems, plus the increased popularity of consumer imports from Europe.

Airlines Selling Hard

Airlines realize that before rate reductions have much impact on air shippers, many months of hard selling are required. This activity, under way for the past year, is aimed at ensuring that the gains in North Atlantic cargo traffic—which averaged an annual 20% during each of the 10 years preceding 1959—do not slip below the present 40% plus growth rate.

Stimulating effects of the all-cargo conversions is illustrated by comparing the tonnage moved on passenger flights, as opposed to tonnage moved by freighter flights, during the last 12 years. In 1948, for example, 2,490 metric tons of cargo traveled across the North Atlantic on passenger aircraft while only 377 tons were carried by freighters.

In 1956, the ratio was 12,404 passenger flight tons to 6,100 freighter tons. During 1959, the ratio was about 4 to 3, while preliminary figures indicate that almost as much cargo business will fall to the piston-driven freighters in 1960 as to passenger aircraft, despite the massive influx of high-capacity jets on the North Atlantic.

Scheduled IATA North Atlantic cargo movement in the first quarter of 1960 increased 51.9% over the comparable three months of 1959, reaching a total of 22,160,377 lb. Of these, 11,871,864 moved westbound, 10,288,513 eastbound.

In 1960's second quarter, a 37.9% jump was recorded, with the bulk of the year's business still outstanding. Approximately 55 to 60% normally is accounted for in the second half. Breakdown of second quarter traffic showed that of 23,451,361 lb. carried, 12,209,861 lb. moved westbound, 11,241,500 moved eastbound. Freighters accounted for 9,741,452 lb., while mixed configuration cargo totaled 13,709,909 lb.

Traffic Indicators

Usually an accurate indicator of air shipping activity over the short term, telephone inquiries in August and to date this month are reported at an all-time high by the optimistic IATA airlines. So are charter bookings, which accounted for about 10% of the North Atlantic freight flow last year.

Unlike earlier years, North Atlantic jet operators do not anticipate that the winter slump in passenger traffic and decline load factors brought on by heightened competition can be compensated for by selling more cargo. On a typical transatlantic crossing, the Boeing 707-300s and the long-range version of the Douglas DC-8 can carry about 10,000 lb. of freight regardless of passenger load, unlike piston-engine transports whose cargo capacity was limited by passenger and fuel weight. Thus, cargo hold space and the average cubic weight of freight are the limiting factors, not the transports' maximum gross weight.

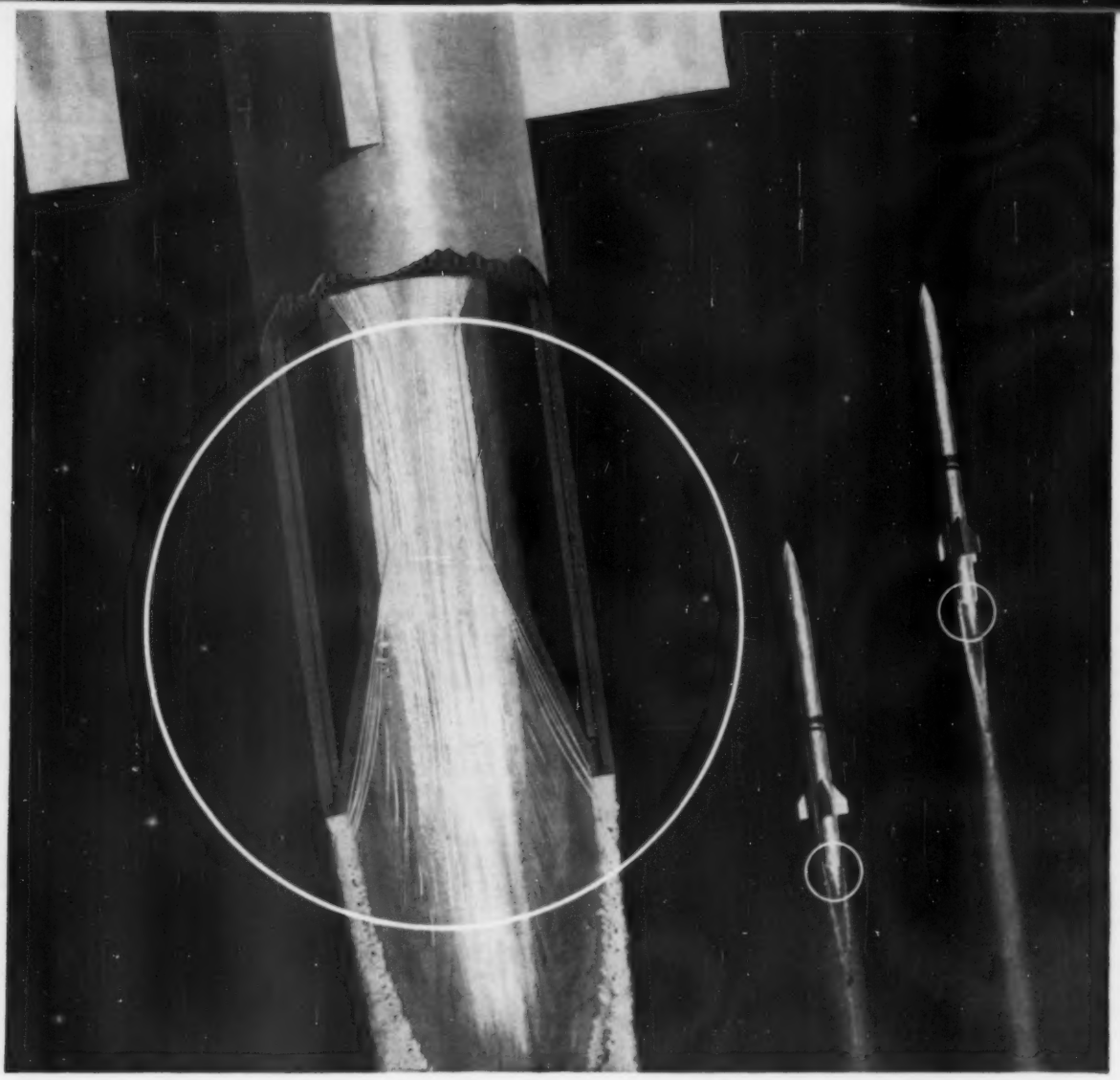
Evidence that the cargo increase in 1960 may dwarf the 45% gain posted in 1959 was furnished AVIATION WEEK by 16 North Atlantic carriers. Here is the bullish picture they forecast:

- **Air France** predicts it will carry 2.5-3 million lb. of cargo across the North Atlantic in 1960, at least 80% more than in 1959. During the first six months of 1960, Air France moved 1,984,000 lb., 45% more than the 1,365,000 lb. it airlifted during 1959's first half. Eastbound total was 1,132,000 lb., a 65% increase. Westbound total was 852,000 lb., an increase of 24%. All cargo was moved and will be moved by passenger flights until "the end of 1960" when the carrier plans to phase in two 1049G freighter conversions.
- **Alitalia,** which began Douglas DC-8 service June 1, expects that in 1960 it will haul 3.25 million lb. of cargo over the North Atlantic. Total in 1959 was about 1.7 million lb. Carrier's first-half figure of 1,193,756 lb. represents a 78% increase over the comparable 1959 period when Alitalia moved 671,237 lb. First-half westbound cargo, 750,434 lb. was up 52% over 1959. Eastbound cargo, 443,332 lb., was up 63%. Average weekly airlift capacity during the first half of this year was 60,000 lb. as opposed to 51,000 lb. last year. Systemwide gross revenue from cargo in 1959 was $3,856,000. In 1960, Alitalia expects freight traffic to produce about $6 million. Two weeks ago, the carrier signed a contract with Douglas to convert two DC-7Cs

Annual North Atlantic Cargo Totals For IATA Airlines

Year	Tons Carried	Per Cent Change
1949	5,412	21%
1950	6,973	29%
1951	8,465	21%
1952	9,467	12%
1953	9,867	4%
1954	11,084	12%
1955	14,524	31%
1956	20,969	44%
1957	22,961	10%
1958	27,565	20%
1959	40,027	45%
*1960	56,294	41%

* Aviation Week estimate based upon cargo carried during first six months of 1960.



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to freighter configuration and set Feb. 1, 1961, as target date for inaugurating all-cargo service.

• **British Overseas Airways Corp.** earned $14,904,294 from its cargo operation during the fiscal year ending Mar. 31, 1960, expects to earn $17,150,000 in its current fiscal year. BOAC hauled 2,319,094 lb. of North Atlantic cargo during the first six months of 1959, then increased this total 43% during the first half of 1960. Westbound total of 1,898,402 lb. represents a 56% increase, while eastbound total of 1,426,403 lb. was up 29% over 1959. BOAC has no all-cargo aircraft at present and no concrete plans to acquire them. Nevertheless, it predicts that in 1960, cargo traffic will approach 7.5 million lb. In 1959, BOAC's North Atlantic freight figure was 4,814,920 lb.

• **Canadian Pacific Air Lines,** which does not operate from U.S. cities to Europe, carried 15,198 lb. of cargo on its route from Montreal to Lisbon, Madrid and Rome during the first half of 1960, 269% more than in 1959. CPA estimates that it will move 35,000 lb. of cargo over this route in 1960; it hauled 9,000 lb. in 1959. Systemwide cargo gross revenue in 1959 was $1,916,502, but CPA expects 2,241,548 in 1960. Carrier's plans to introduce all-cargo aircraft are "indefinite."

• **El Al Israel** reported one of the three declines in AVIATION WEEK's survey: eastbound freight carried during the first six months of 1960 fell 5.4% from the 1959 level to 209,939 lb. Despite this, the Israeli airline reported an over-all 14% gain in its first half freight flow of 615,500 lb. In 1959, it carried 1,107,546 lb. across the North Atlantic.

• **Iberia,** the Spanish airline, moved 338,206 lb. during 1959, expects to move 358,722 lb. during 1960 for a 6% increase on its North Atlantic routes. Iberia has no immediate plans to purchase freighters.

• **KLM Royal Dutch Airlines,** for 12 years an operator of all cargo aircraft on North Atlantic routes, feels that in 1960 it will carry about 15 million lb. of freight, 4 million more than it carried in 1959. KLM's first-half 1960 total of 6.6 million lb. represents a 35% increase over last year, when 4.9 million lb. were moved. Westbound freight flow was up 24% at 3.1 million lb., eastbound increased 46% to 3.5 million lb. According to the carrier, the first of six DC-7Fs now being converted will be introduced in North Atlantic service in late October. Then KLM will dispose of its single DC-6A but retain its fleet of five Lockheed 1049Hs. Operating jets since Apr. 16, KLM carried 3.2 million lb. of cargo on passenger flights and 3.4 million lb. on freighter flights in the first half of 1960. Systemwide cargo revenue of 21.5 million was reported in 1959; $25 million is expected in 1960 period.

Los Angeles Airways Receives S-62

Sikorsky S-62 single-turbine helicopter has been delivered to Los Angeles Airways (AW Sept. 12, p. 47). The 9-12 passenger amphibious aircraft will be the first turbine-powered helicopter in scheduled airline service. The S-62 is leased by LAA, which has ordered five twin-turbine S-61s for 1961-62 delivery.

• **Lufthansa German Airlines** carried 2,449,186 transatlantic pounds in the first six months of 1960, 76% more than it carried in 1959's first half. Eastbound airlift was up 98% to 1,387,932 lb., westbound increased 54% to 1,057,122 lb. Average weekly capability rose constantly during the period as Lufthansa phased in both 707-420s and two L-1649 freighters. Airline's 1960 prediction is 8.5 million lb., more than double the 3,341,899 lb. moved during 1959. Lufthansa carried 960,944 lb. of freight in all-cargo aircraft, 1,488,242 lb. on passenger flights during first-half 1960.

• **Loftleidir Icelandic Airlines,** the only scheduled carrier on the North Atlantic not an IATA member, predicts a 32% increase in 1960 when the airline hopes to carry 450,000 lb. It carried 341,448 in 1959. First six months figures show Loftleidir moving 180,451 lb., of which 72,675 were westbound and 107,776 eastbound.

• **Pan American World Airways** led North Atlantic carriers in cargo as well as passenger traffic by moving 8,206,000 lb. of freight during the first half of 1960. This represents a 50% increase over 1959's level of 5,475,000. Breakdown of 1960's first half total shows westbound cargo up 76% to 4,303,000 lb., eastbound cargo up 29% to 3,903,000 lb., 4,212,000 lb. moving on freighter flights and 3,994,000 lb. moving via the holds of passenger aircraft. Operating six DC-7Fs on transatlantic schedules, Pan American predicts that more than 20 million lb. will be carried in 1960, or 50% more than the 13,341,000 lb. carried in 1959.

• **Qantas Empire Airways** posted an over-all 25% increase after the first six months of this year, but still slipped 30% in first-half cargo carried westbound, which dropped from 142,000 lb. in 1959 to 100,000 lb. in 1960. Total traffic growth came from a 210% increase eastbound. Qantas, without freighters, feels that it will carry 500,000 lb. this year, substantially bettering 1959's total of 380,000 lb. Gross revenues accruing from cargo in 1959 were $6,267,520; in 1960, the carrier expects to earn $7,866,880.

• **Scandinavian Airlines System** plans to introduce an indefinite number of DC-7F conversions "before the summer of 1961," already operates the freighters on its intra-European routes. SAS estimates that it will move 6 million lb. in 1960, building with a 22% growth rate. During the first half, the carrier hauled 1.6 million lb. westbound and 1.4 million lb. eastbound, recording gains of 23% and 21% respectively. Average weekly capacity rose from 207,000 lb. in 1959 to 230,000 lb. in 1960.

• **Sabena Belgian World Airlines,** with two DC-7C freighter conversions due this fall, reports a 96.7% increase in North Atlantic cargo during the first half, the peak growth rate among the major carriers. The airline accounted for 2,185,867 lb. in 1960's first six months, 1,111,215 lb. in the same

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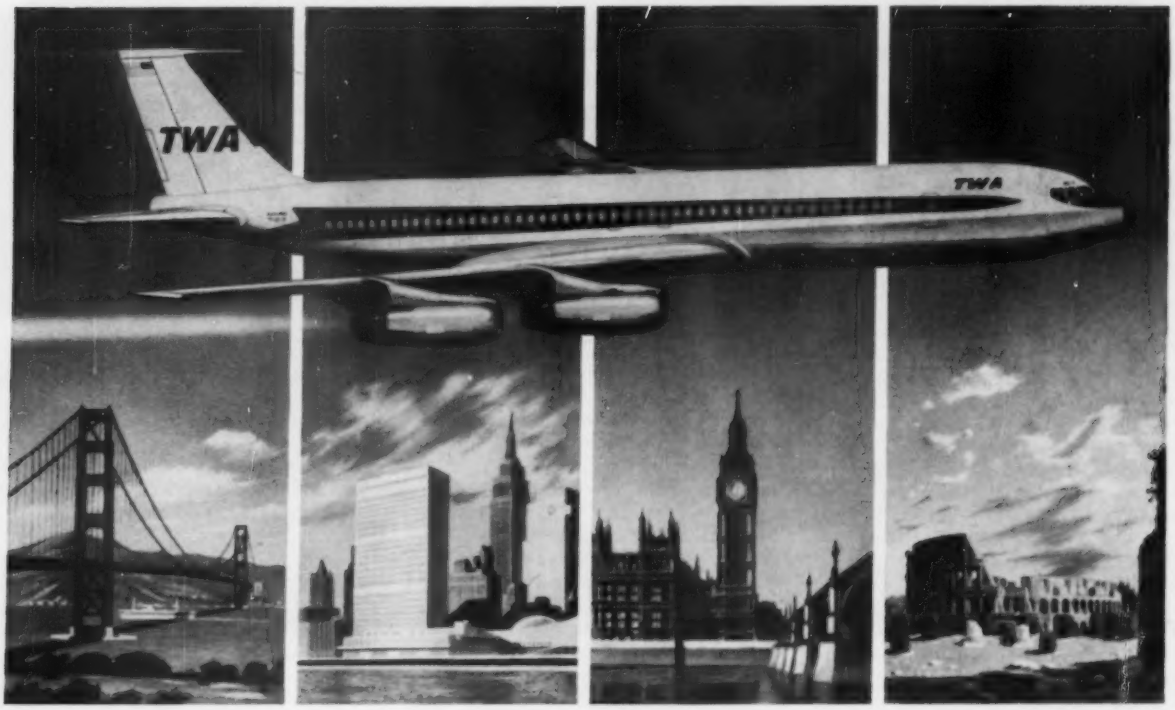

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period of 1959. East and westbound cargo capability for the first half of this year was 3,132,000 lb. Last year it was 1,662,200 lb. First Sabena jet service began Jan. 23.

• **Swissair** forecasts, which estimate 2.7 million lb. in 1960, are based on a 29% gain over 1959's total of 2,083,664 lb. The carrier operates one DC-6A freighter on the North Atlantic and two more in Europe but has reached no decision on acquiring additional all-cargo aircraft.

• **Trans-Canada Air Lines** predicts only a 1.4% increase in North Atlantic cargo for 1960 and looks for a year-end total of 2,166,556 lb. In 1959, TCA moved 2,136,820 lb. During the first six months of 1960, TCA's eastbound cargo was down 2% to 383,783 lb., its westbound cargo up 36% to 881,805 lb.

• **Trans World Airlines,** which expects an 80% increase in 1960 North Atlantic cargo, plans to introduce the first of six Lockheed 1649 freighter conversions this month on its route from New York to London, Paris, Rome, Milan, Frankfurt, Zurich and Geneva. Meanwhile, two 1049Hs are being used to haul transatlantic freight. Weekly average airlift capability of TWA rose from 300,800 lb. in June, 1959, to 904,800 lb. in June, 1960. The carrier's first half total of 3,360,481 lb. represents an 87.8% increase over 1959's first six months when 1,789,578 lb. were moved. Breakdown shows a 134% eastbound increase and a 53% westbound increase. In 1959, TWA carried 4,546,000 lb., estimates that this year it will carry 8.2 million lb. and earn $15 million systemwide from freight service.

To many observers who expected the new jets to dominate transatlantic cargo traffic this year, the share of business captured by converted freighters is surprising. Three major factors apparently are responsible for the fact that freighter-carried cargo is increasing more rapidly than cargo carried by passenger aircraft.

First is the influx of capacity from the freighters themselves. With the used plane market for DC-7s and Super Constellations decidedly soft, carriers are taking a hard look at the earning potential of the big piston-driven transports, many of which already are written off. If North Atlantic freight flow continues to grow at its present pace, more conversion orders seem inevitable.

Shippers also realize that jet schedules are predicated on passenger comfort, while freighter schedules usually are timed to deliver cargo at the break-bulk or pick-up point to meet rail and truck connections. Freight forwarders think in terms of delivery the first or second morning after departure, with the emphasis on "morning." Despite the jets' speed advantage, freighter flights often can offer first morning delivery at prime European gateways when the jets cannot.

Because these schedules have been worked out by the carriers' cargo sales departments, and because the freighters can only turn a profit with relatively high cargo load factors (while an empty hold is not an economic penalty to a passenger-carrying jet), most airlines are concentrating their cargo sales efforts on freighter flights.

Optimistic forecasts of North Atlantic cargo growth also are supported by the IATA rate structure, which has kept the cost of international shipment considerably higher than comparable air freight rates within the United States. Correspondingly—according to Prof. Stanley H. Brewer, transportation expert at the University of Washington—international rates probably will drop faster than domestic rates, thus encouraging prospective transatlantic shippers.

As airlines explore volume movement, back haul traffic stemming from one-way charters and deferred commodity rates, this downward rate trend can be expected to accelerate. Acquisition of surplus DC-7s and Super Constellations by supplemental carriers also will furnish IATA airlines with a powerful incentive to keep rates dropping in the face of mounting competition for cargo in the expanding North Atlantic market.

Coach Fare Increase For Jets Requested

Washington—Four more transcontinental air carriers have joined United Air Lines in asking the Civil Aeronautics Board for increased turbojet transport coach fares.

American, Trans World, Continental and Northwest airlines filed with the CAB for jet coach fare increases designed to bring them within 75% of first class fares.

All five carriers stress the fact that the type of service offered in coach sections of their turbojet transports does not differ to any great degree from that offered in first class sections. Thus, differences of up to 36% between first class and coach fares are considered unreasonable and uneconomical by the airlines. The new tariffs would bring that difference down to a maximum of 25%. They are filed to be effective Oct. 1.

In other tariff action, the CAB suspended tariffs on six of nine segments filed for on Delta Air Line's system calling for air coach fare increases, which would exceed the coach fare ceiling of 75% of the first class fare as provided in the Board's domestic coach policy. The Board deferred action on the remaining three segment increases pending further analysis.

Eastern Proposes Low Fare Service to CAB

New York—A long-haul no-reservation, reduced fare service designed to be competitive with bus and automobile transportation has been proposed by Eastern Air Lines in an application to Civil Aeronautics Board for a new Pittsburgh-Miami tariff.

To get the traveler away from his automobile or economy bus trip, Eastern plans to offer Lockheed Super Constellation service at $40 one way under the new plan. Passengers who take advantage of the high-density, no-frills air transportation will be able to buy tickets and proceed directly to their flights without making reservations or checking in.

The fare represents a 26% reduction from lowest current coach tariffs. Under the plan, tickets for seats on the 95-passenger Super Constellations will be sold up to 90 days in advance. Once all seats have been disposed of, the flight will be sold out. Cancellations must be made more than 24 hr. in advance of departure time. Later cancellations or no-shows will be entitled to no refund.

Eastern offers this comparison of highway, rail and air transportation between Pittsburgh and Miami in considering the proposed new fares:

Eastern Airplane	Highway Bus	Railroad Coach	Private Car
Time 4 hr.	25 hr.	31-32 hr.	3 days
Fare $40	$40.45*	$46.22*	$45†

* Including meals en route.
† Average per person, two per car, including meals and motel for two nights (AAA estimate).

Two-Year IATA Rates Proposed by CAB

Washington — Civil Aeronautics Board, in a letter to 16 U. S. carriers last week, urged that passenger fares and cargo rates set by the International Air Transport Assn. be effective for two years instead of one.

Terming annual renegotiation "burdensome" and "unsatisfactory," the Board suggested that carriers opposing the two-year IATA rates be required to give notice of an intent to void at least eight months in advance.

This provision, CAB said, would ensure that airlines "would not be required to charge fares or rates to which they no longer acceded." U. S. carriers unanimously have concurred with the Board's suggestion.

Specifically, a carrier wishing to void an IATA rate established for two years beginning Apr. 1 would have to file notice no later than Sept. 1. This would convene a special meeting of IATA's Traffic Conference with its agenda limited to the disputed rate.

Convair 880's like the "Delta Queen" are now setting new records on Delta's scheduled flights.

Flying time between New York and New Orleans for example, is only 2 hours, 10 minutes.

TEXACO LUBRICATES WORLD'S FASTEST JETLINER

G-E Powered Convair 880 "Delta Queen" sets new coast-to-coast speed record... averages 667 mph.*

Four mighty G-E CJ805-3 engines are a big reason for the Convair 880's incredible speed. These engines are so powerful, that even with a full load, the 880 can operate in and out of most airports accommodating today's piston engine aircraft.

General Electric used Texaco Synthetic Aircraft Turbine Oil 15 lubricant in the development of the CJ805-3. Now SATO 15 keeps it operating at peak efficiency in regular flight.

Texaco Synthetic Aircraft Turbine Oil 15 is just one of a complete line of fine lubricants and fuels which Texaco supplies to the aviation industry. For complete data, contact any one of the more than 2,300 Texaco Distributing Plants, or write:

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LUBRICANTS
AND FUELS

FOR PURE JET, TURBO-PROP AND PISTON-ENGINE AIRCRAFT

*Actual flight time between San Diego and Miami: 3 hours, 31 minutes, 54 seconds. Average speed: 667.95 mph.

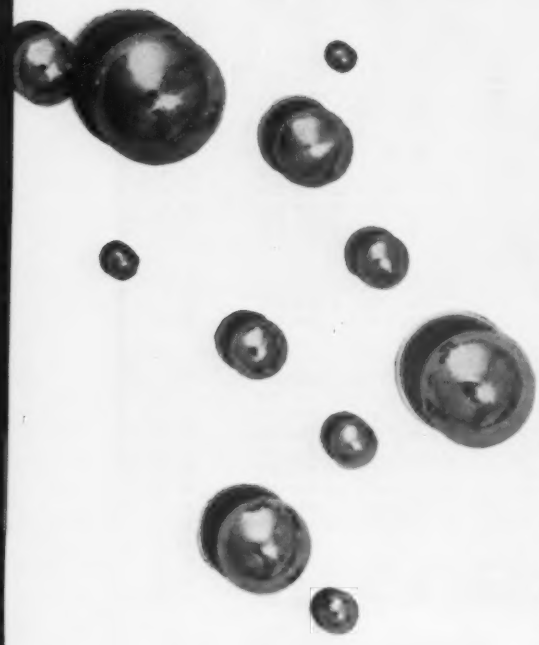
Airline Traffic—July, 1960

	Revenue Passengers	Revenue Passenger Miles (000)	Passenger Load Factor %	U. S. Mail Ton-Miles	Express Ton-Miles	Freight Ton-Miles	Total Revenue Ton-Miles	Over-all Revenue Load Factor %
DOMESTIC TRUNK								
American	695,738	588,783	67 5	1,676,021	862,414	8,478,707	67,417,679	56 9
Braniff	183,148	91,449	58 5	414,813	156,271	601,195	9,936,946	47 5
Capital	301,786	125,764	51 1	519,860	269,275	436,244	13,280,303	47 2
Continental	121,299	90,303	56 3	207,520	101,491	450,459	9,410,133	45 0
Delta	268,965	144,275	56 7	438,395	258,025	1,124,090	15,662,374	47 5
Eastern	633,992	343,156	52 69	1,103,522	484,986	1,676,332	36,261,089	40 7
National	130,139	80,548	51 7	281,202	52,743	611,693	8,704,625	40 5
Northeast	131,827	48,108	50 8	104,841	33,625	240,370	4,979,195	44 1
Northwest	159,819	121,630	58 6	576,384	271,747	1,384,202	13,868,457	51 6
Trans World	435,055	447,716	69 4	1,428,450	685,991	3,616,061	48,622,882	54 4
United	691,076	526,056	69 8	2,834,775	857,291	5,726,528	59,853,871	58 6
Western	153,024	92,853	57 9	301,001	96,944	289,605	9,567,770	53 8
INTERNATIONAL								
American	10,116	10,819	66 8	8,920	486	207,459	1,333,389	66 8
Braniff	6,437	13,895	65 8	36,478	.....	178,663	1,681,773	58 3
Caribbean Atlantic	39,099	2,770	67 8	1,800	.....	8,829	269,374	66 5
Delta	2,921	4,048	45 4	6,268	.....	27,823	472,735	40 7
Eastern	61,899	90,306	71 66	77,279	.....	184,255	9,440,311	64 0
Mackey	11,552	2,838	54 3	.....	166	3,935	309,668	57 2
National	3,766	3,070	71 7	3,190	1,398	6,467	338,883	75 2
Northwest	19,316	35,974	57 0	1,138,841	18,178	873,398	5,835,189	56 9
Pan American								
Alaska	8,327	8,464	65 6	39,864	.....	193,645	1,118,442	65 1
Atlantic	165,501	242,366	68 0	1,862,201	.....	4,639,711	31,599,813	60 0
Latin America	119,501	149,586	77 0	455,086	.....	4,147,969	18,898,298	67 0
Pacific	38,860	131,830	68 2	1,625,222	.....	2,412,567	17,737,659	59 3
Panagra	10,769	18,198	60 2	80,933	.....	618,135	2,648,123	58 9
Resort†	.....	.....	.....	.....	.....	.....	.....	.....
Trans Caribbean*	.....	.....	.....	.....	.....	.....	.....	.....
Trans World	49,618	159,419	69 7	1,157,948	.....	1,554,911	19,119,351	63 6
United	22,162	55,113	76 7	224,323	10,613	196,082	6,014,610	64 7
Western	4,174	6,491	59 6	8,569	.....	26,456	709,855	61 8
LOCAL SERVICE								
Allegheny	61,909	12,269	41 3	14,433	24,987	42,511	1,252,784	41 7
Bonanza	21,862	5,547	36 8	6,384	2,881	10,555	541,867	37 3
Central	15,525	2,980	40 7	8,132	3,097	9,959	306,501	36 6
Frontier	30,879	8,287	41 1	24,236	10,447	64,811	898,503	45 0
Lake Central	18,499	3,006	36 8	5,662	15,765	.....	308,978	40 3
Mohawk	51,950	10,774	43 0	15,010	17,104	17,099	1,076,348	39 7
North Central	87,957	16,254	46 24	37,190	46,615	38,547	1,700,051	47 09
Ozark	47,113	8,532	39 0	15,924	24,239	25,764	881,807	42 2
Pacific	46,254	10,602	54 3	16,440	4,128	8,501	1,039,998	47 6
Piedmont	41,371	8,941	47 2	13,177	12,191	18,759	898,581	48 1
Southern	7,634	1,410	42 8	4,369	3,076	4,272	146,408	44 2
Trans-Texas	25,843	6,033	39 29	19,921	10,845	36,511	643,504	40 17
West Coast	37,071	8,967	49 18	13,367	5,018	25,368	900,091	49 34
HAWAIIAN LINES								
Aloha	41,812	6,551	65 1	2,633	.....	8,497	536,793	54 7
Hawaiian	58,433	14,537	71 1	12,337	.....	203,182	1,435,035	66 2
CARGO LINES								
AAXICO†	.....	.....	.....	.....	.....	.....	.....	.....
Aerovias Sud Americana	.....	.....	.....	.....	.....	572,034	572,034	75 1
Flying Tiger	7,220	15,946	75 2	24,877	40,988	7,317,689	8,978,140	71 3
Riddle*								
Domestic	.....	.....	.....	.....	.....	.....	.....	.....
Overseas	.....	.....	.....	.....	.....	.....	.....	.....
Seaboard & Western	2,747	10,531	100 0	759,641	.....	3,606,754	5,433,302	82 3
Slick	2,600	11,634	100 0	.....	.....	2,619,812	3,783,153	100 0
HELICOPTER SERVICE								
Chicago Helicopter	29,286	492	49 1	1,281	.....	.....	48,211	41 0
Los Angeles Airways	4,494	150.7	58 0	4,554	2,179	.....	21,162	66 0
New York Airways	15,047	290	56 0	1,739	1,259	529	31,286	55 4
ALASKA LINES								
Alaska Airlines	11,627	9,379	59 7	66,878	5,546	336,874	1,337,257	64 3
Alaska Coastal	7,908	736	56 8	3,599	.....	6,467	84,606	57 3
Cordova	2,067	486	54 2	3,979	.....	54,331	107,625	56 5
Ellis	7,815	441	56 5	2,319	.....	3,728	50,723	64 9
Northern Consolidated	4,349	1,383	49 2	31,419	.....	74,497	255,132	62 0
Pacific Northern	13,612	14,113	63 0	115,156	7,925	408,817	2,062,286	75 0
Reeve Aleutian	1,460	69	45 6	48,068	.....	77,537	269,953	64 7
Western Alaska	1,642	98	.....	525	.....	1,809	11,706	68 5
Wien Alaska	6,985	2,561	70 0	48,138	.....	136,024	443,324	50 7
Avalon Air Transport	17,713	727	54 7	775	.....	947	70,833	56 0

* Not available. † No operations in July.

Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

DURABLE IN THE EXTREME



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A leading manufacturer of ball bearings uses Republic Type 52100 Vacuum-Melted Alloy Steel in bearings produced for aircraft and missile applications. This steel provides excellent resistance to erosion, corrosion, abrasion, and impact. The alloy is supplied to the manufacturer in bars. It is then drawn into wire rods, annealed, drawn to size, sheared into slugs, forged, heat treated, rough ground, tempered, finish ground, and polished.

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REPUBLIC VACUUM-MELTED METALS are produced in 18- to 32-inch diameter ingots weighing from 4,000 to 20,000 pounds. These can be processed into billets, sheets, bars, strip, and wire to meet your precise requirements.

REPUBLIC STAINLESS STEEL is used in leading edges of the Convair 880's vertical fin and horizontal stabilizer where anti-icing is accomplished through electrical heating of the metal. Use of Republic ENDURO® Stainless Steel increases strength and heat-resistance, permits thinner, lighter gages. Types 301 and 302 are readily formed into desired shapes by cold forming, drawing, and bending operations.

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AIRLINE OBSERVER

▶Nub of the Trans World Airlines financing deadlock appears to be the effort by the financial group to have an independent director, or directors, named to the carrier's board. Howard Hughes, who can elect TWA's board through his 70% stock ownership, so far is adamantly opposed. Speculation in New York financial circles is that financing will be arranged, but that there may be changes in the syndicate members and that Hughes may pay a higher price in interest rates or in added equity financing than that entailed in the original $340 million package. Hughes' dickering with Convair is intermixed, with Hughes objecting to Convair that specific fuel consumption of the General Electric CJ805 engines is too high on the Convair 880 and seeking to have the dozen 880s waiting on the ramp for TWA modified with turbofans. An order for Convair 600s for TWA also is involved in the negotiations (AW Aug. 22, p. 50).

▶High cost of aircraft hull insurance is stimulating an increase in self-insurance plans by many airlines. Qantas Airways is now self-insuring its entire fleet and by the end of 1959 had accumulated a reserve of $1,065,000 for this purpose. Pan American World Airways also is working toward an eventual $10 million reserve for partial coverage of its fleet. British European Airways, which had a Fiscal 1959 appropriation of $280,000 for this purpose, has increased this sum to $1.4 million for the current year.

▶Civil Aeronautics Board has taken steps to confine the length of briefs submitted by airlines. Airlines are limited to briefs of no more than 50 pages, but Board members complained that the carriers have been submitting single-spaced documents in small type with lengthy appendices, tables and charts attached. A new regulation amendment now holds briefs to double spacing, with any additional charts or evidence considered a part of the 50-page limit.

▶Federal Aviation Agency is exploring the possibility of seagoing Vortac stations across the Atlantic. Next month a Vortac-equipped U. S. Coast Guard cutter will begin preliminary tests along the East Coast for the airline, military and FAA, to be followed in November by a three-week test in the North Atlantic. FAA hopes the seagoing navigational aids may result in a reduction of current 30-min. separation required for transoceanic flights.

▶Eastern Air Lines and the Railway Express Agency are now offering shippers a new air freight, surface express service designed to reach cities without airports. Shippers will receive local pickup and delivery as part of a single air freight billing, based on a combination of air and surface rates of the two carriers.

▶Icelandic Airlines attained an average system load factor of 70% during Fiscal 1959 with a 10-hr.-a-day utilization on DC-4N and DC-6B equipment.

▶Export-Import Bank has agreed to loan $8.9 million to El Al Israel Airlines to be put toward purchase of two Boeing 707 turbojets. Scheduled for repayment over a seven-year period, the loan covers the major portion of the cost of airframes, airframe spares and ground equipment. Balance of the cost is being financed by El Al and Boeing.

▶Japan Air Lines last year carried 43% of the 65,300 passengers on the Central Pacific air routes; about 6% of the 33,600 on the Northern Pacific routes and nearly 15% of the 126,500 on the Southeast Asia routes, according to a Department of Commerce survey. Traffic totals on the Pacific routes were made in competition with five other airlines.

▶KLM Royal Dutch Airlines has scheduled its first DC-7F all cargo aircraft for a five day sales tour of the U.S., beginning Oct. 10. Aircraft will visit Los Angeles, San Francisco, Chicago, Philadelphia and Washington, D.C. with an exhibit of typical cargo handled by the airline and a group of air cargo experts from Holland, England, Italy and Switzerland.

▶Rapidly growing circulation of Russia's Ministry of Foreign Trade publications is being used to promote Aeroflot's international services in other countries. Moscow was once reluctant to give Aeroflot timetables to foreigners even on request. Recent issue of the ministry's organ, Vneshnyaya Torgovlya included a separate, full-color Aeroflot schedule in English, advertising Europe-Asia flights through Moscow.

SHORTLINES

▶**Aloha Airlines'** and Hawaiian Airlines' recently-filed tariffs for general increases in one-way passenger fares of 4% plus $1.00 per ticket, which would have become effective last week, have been suspended by the Civil Aeronautics Board pending investigation.

▶**Civil Aeronautics Board** Examiner F. D. Moran has recommended that the foreign air carrier permit of Lineas Aereas de Nicaragua, S. A., be renewed for three years. The Nicaraguan airline services the U. S. at Miami from Managua via the intermediate point of San Salvador, El Salvador.

▶**Eastern Air Lines** reports an increase of 23% in cargo ton-miles and 19% increase in dollar revenue for air freight in the first six months of 1960. EAL carried 23,899,187 lb. of air freight 10,230,520 ton-miles in the first-half period, against 19,847,952 lb. of cargo carried 8,342,728 ton-miles in the first six months of 1959. Air freight revenue for 1960 was $2,630,269. Also during the first half of this year, EAL carried 14,831,757 lb. of air express, 19,223,462 lb. of air mail and 3,156,615 lb. of non-priority first class mail.

▶**Federal Aviation Agency** is instructing more than 100 FAA safety inspectors in specialist pilot training in operation of turbojet, turboprop and other higher performance aircraft. Purpose is to be sure inspectors have the same knowledge and skills as the airline pilots they are monitoring. Aircraft in the program are: Boeing 707 series; Douglas DC-8; Convair 880; Lockheed Electra; Vickers Viscount series; Fairchild F-27; Convair 340; Lockheed Constellation series and Armstrong Whitworth Argosy. Other aircraft will be added later.

▶**Japan Air Lines** has scheduled Oct. 1 as starting date for twice-weekly Douglas DC-6A airfreighter service between San Francisco and Tokyo, via Honolulu. JAL plans to convert two of its Douglas DC-7C airliners from passenger configuration to air freight aircraft as soon as the company's Douglas DC-8C turbojet airliners take over passenger flights. The DC-6As have a capacity of 15,000 lb. and the DC-7Cs will have a payload capacity of 30,000 lb.

▶**Transocean Air Lines'** application for acquisition of Air Jordan Co., Ltd., has been dismissed by the Civil Aeronautics Board at the request of Transocean. The U. S. carrier informed the Board that it had disposed of "all its rights, title and interest in Air Jordan. . . ."

This piston plug is a Pratt & Whitney Aircraft *original equipment part.* Though inexpensive, it is made with exacting precision. Only the most accurate shadowgraph can measure the radius of its curved surface where it touches the cylinder wall.

The slightest flaw in this radius can result in spinning, rapid wear and partial disintegration of the piston plug. This can cause failure of the piston and the cylinder, or bearing failure through contamination of the lubricating system.

Original equipment parts protect your engine against such serious consequences. A few pennies saved on a look-alike substitute will never compensate for expensive repairs.

Pratt & Whitney Aircraft engines are designed and built to the highest standards of dependability, requiring constant testing and refinement of every engine part. Without these continuing improvements, no substitute can match the dependability of Pratt & Whitney Aircraft *original equipment parts.* They are quickly available direct from Pratt & Whitney Aircraft or its authorized distributors in the United States and Canada.

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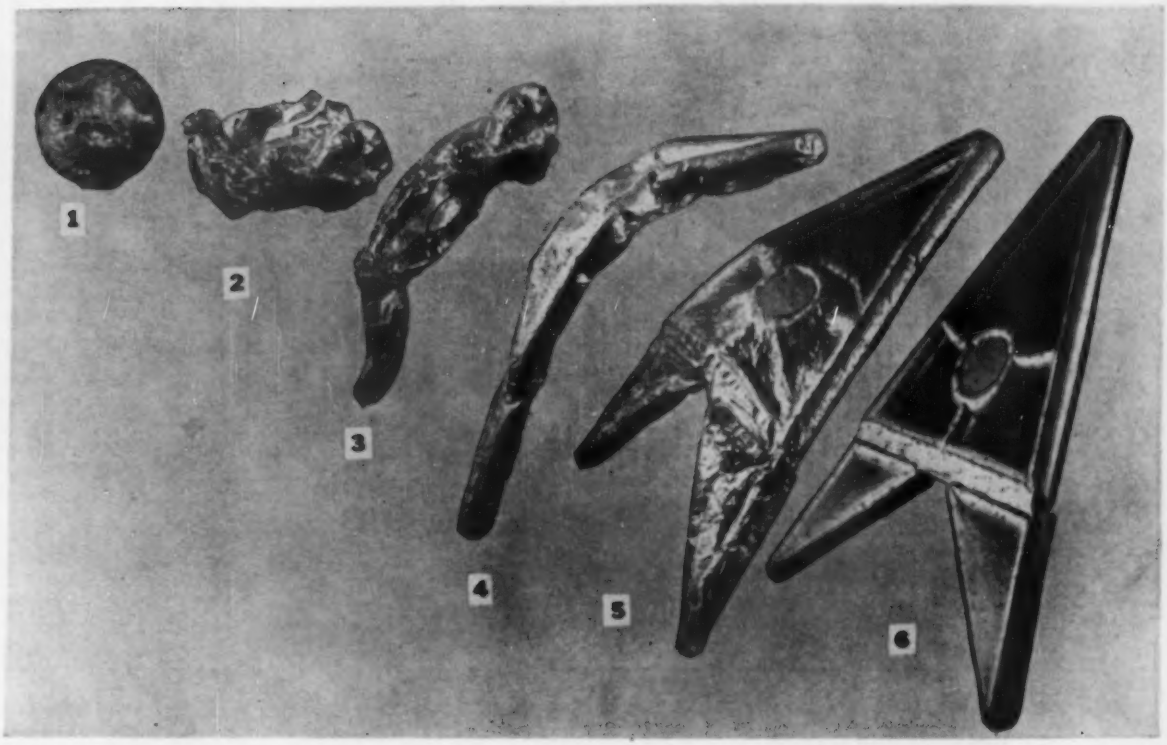


FAST ACTION sequence shows the various stages of inflation of a foldable re-entry vehicle which could operate from a space platform in controlled return to earth.

Echo I Advances Flexible Spacecraft Tests

By Edward H. Kolcum

Langley Field, Va.—National Aeronautics and Space Administration sees the Echo I experiment as a realistic verification of theories for putting ungainly structures in space by inflating them after they have passed through the atmosphere.

The 100-ft. Echo inflatable sphere (AW Aug. 22, p. 30) is considered forerunner for a virtually limitless variety of flexible spacecraft as well as for extension of world-wide communications. Space Vehicles Group at Langley Research Center already has done basic design work, including wind tunnel studies, on inflatable lift vehicles, sailplanes, kites, solar collectors, corner reflectors and manned orbital laboratories.

Industry interest in the fundamental concepts of foldable structures in areas other than communications has been evident in a number of company proposals for such structures. For example, G. T. Schjeldahl Co. of Northfield, Minn., which manufactures Mylar spheres for NASA, has an extensive "satelloon" program under way to determine best design and methods for making a passive communications reflector rigid.

General Electric Co. has designed inflatable "sausages" as emergency spacedocks to repair and service conventional, rigid space vehicles.

Schjeldahl work will include study of erecting vehicles by foam, photo-chemical means, solar radiation, electrostatic charges and stiffening metal foils.

ERECTABLE structure model was used at Langley Research Center for wind tunnel studies of static loads. Full-scale glider would be 120 ft. long with 70 ft. span.

NASA studies are aimed at providing functional spacecraft designs with configurations based on mission rather than dictated by booster capability. Rigid structures mounted to the nose of a booster are limited in weight and size, and they present difficult stability problems. Flexible structures, characterized by very light weight materials such as Mylar, could be folded and packaged in relatively small containers and expanded into massive, rigid structures in space.

NASA says light, winged vehicles are slowed by drag at higher altitudes when they re-enter the atmosphere, thus reducing re-entry heating problems. The agency's research extends to studies of materials improvement so that acceptable heat shielding could be included in a flexible, manned re-entry glider.

Materials in Echo satellite—aluminized Mylar with thickness of .0005 in.—is acceptable for non-returning spacecraft applications but not for re-entry vehicles since it is expected to burn up on re-entry. Precision techniques for folding, instrumenting and pack-

aging, developed from preparing ten 100-ft. payloads, are applicable generally to all large expandable vehicles, according to William J. O'Sullivan, Jr., Space Vehicles Group head.

O'Sullivan also heads Langley's Echo group, which designed the 100-ft. sphere and devised the means for packing the 31,000 sq. ft. vehicles into a container with 26.5-in. diameter. Payloads are packed by employes from space vehicles, engineering services and technical services staffs.

Sphere is received at Langley in 100-in. square container from Schjeldahl with all 82 gores sealed except one. At this point, the vehicle is flat and is about 158 ft. long.

Sphere then is folded in two piles, sublimating powders inserted, instruments and polar caps installed and final seal made. After seal, 242 pin holes are punched in the vehicle to provide outlet for final air evacuation and to slow inflation when it goes into orbit.

Packing process involves four air evaluations: first by hand pressing, second by vacuum machine before packing into container, and final two when payload spends 48 hr. in a pressure chamber. Each pile is packed into a magnesium hemisphere in spiral fashion. The neoprene-lined container has strings extending from poles to equator to provide paths for air escape.

Container Tests

Environmental vibration tests of completed payload are held at Langley, and the container then is sent to Wallops Station for balance tests. If not in balance, container has weights added to top hemisphere, which is three pounds lighter than bottom. After shake and balance tests, the hemispheres are joined by 72 holding clamps placed over a linear charge which separates them in orbit.

Residual air pressure in the sphere when the payload hemispheres are locked is 1.5 mm. of mercury, enough to begin the inflation process.

Although sublimating powders were used to sustain Echo inflation, NASA designed a compressed nitrogen system to expand Beacon satellites. Two attempts to orbit 12 ft. Beacon inflatable spheres failed because of booster malfunctions.

NASA is considering combinations of spinning and mechanical means of space erection along with inflation. Centrifugal force in spinning could unfold large winged re-entry gliders launched in cylindrical packages.

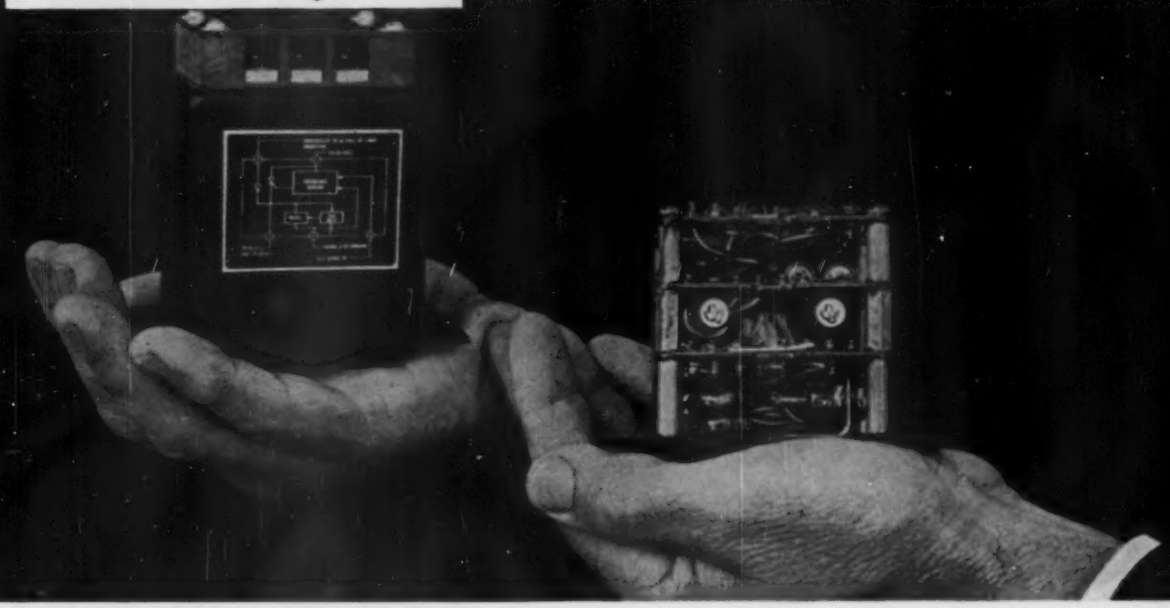
At Langley, scientists have conceived an orbiting laboratory using compressed gas to extend compartments like a telescope. Solar collector power source would look much like an umbrella with rigid members mechanically locked into place.

ECHO satellite container (below) is made ready for the 100-ft. mirco-thin sphere. Neoprene-lined magnesium flight package has 26.5 in. dia. Cotton strings provide paths for trapped air to escape during evacuations. Folding process (above) was developed at Langley Research Center and is applicable to shaped vehicles as well as spheres.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

SPECIFIES TI CONTROLLED RECTIFIERS FOR RELIABLE TURBINE OVERSPEED MONITOR



All-diffused TI 2N1595 in TO-5 case provides superior static control

Engineers at the Los Angeles AiResearch Manufacturing Division of the Garrett Corporation designed the Turbine Overspeed Monitor for use in missiles and aircraft. This 12-ounce unit utilizes electromagnetic sensing at 5000 cps for firing TI silicon controlled rectifiers to provide 1 amp of corrective current at 24 volts dc.

To obtain top missile reliability, AiResearch specified TI 2N1595 silicon controlled rectifiers. These all-diffused highly reliable devices provide unique device characteristics, size and weight savings . . . in the more economically priced TO-5 case. TI provided AiResearch with controlled rectifiers featuring guaranteed specifications, tighter leakage tolerances, and consistent stability.

In addition to controlled rectifiers, AiResearch engineers have designed other TI components into such equipment as temperature controls, frequency converters, and frequency monitors . . . applications where maximum reliability is of paramount importance.

Contact your nearest TI sales office for price, delivery, and technical information concerning all reliable TI components.

Remember . . . you can *rely* on TI!

SILICON CONTROLLED RECTIFIERS

Type	At 80°C Case Temp: Av Rect Fwd Current Amps	At 80°C Case Temp: Recurrent Peak Current Amps	Non-Recurrent Surge Current 1 Cycle at 60 cps Amps	Min Fwd Off Voltage* v	PIV	Min Breakdown Voltage v	Max Case Temp °C	Max Fwd Gate Current ma	Gate to Cathode PIV v	max Fwd Voltage Drop @ Avg Rect Fwd Current @ 25°C Stud Temp v @ a	Gate Current Req to Fire ma: Typ	Gate Current Req to Fire ma: Max
2N1600	3	10	25	50	50	60	150	100	5	2 @ 3 amps	1	10
2N1601	3	10	25	100	100	120	150	100	5	2 @ 3 amps	1	10
2N1602	3	10	25	200	200	240	150	100	5	2 @ 3 amps	1	10
2N1603	3	10	25	300	300	360	150	100	5	2 @ 3 amps	1	10
2N1604	3	10	25	400	400	480	150	100	5	2 @ 3 amps	1	10
2N1595	1	3	15	50	50	60	150	100	5	2 @ 1 amp	1	10
2N1596	1	3	15	100	100	120	150	100	5	2 @ 1 amp	1	10
2N1597	1	3	15	200	200	240	150	100	5	2 @ 1 amp	1	10
2N1598	1	3	15	300	300	360	150	100	5	2 @ 1 amp	1	10
2N1599	1	3	15	400	400	480	150	100	5	2 @ 1 amp	1	10
TI-010	1	3	15	50	50	60	150	100	5	See data sheet for switching information		
TI-025	1	3	15	50	50	60	150	100	5			
TI-050	1	3	15	50	50	60	150	100	5			

*Measured with 1K ohm resistor gate to cathode

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FLEXIBLE-WING GLIDER MODEL mounted in wind tunnel at Langley Research Center (left) has a spherical crew capsule attached to its shroud lines. Stiff, inflated shroud lines, wing leading edges and the center keel all would be about 2 ft. in diameter on a full-scale vehicle. Flexible membrane between the two leading edges and the keel would be made of wire cloth coated with high-temperature silicon material. Flexible wings also are being studied to reduce the landing speed of supersonic and hypersonic aircraft (right). Wing would be carried in a small tubular container on top of the aircraft during high-speed flight and deployed at subsonic speeds for landing.

Cloth Wings Studied for Orbital Gliders

By J. S. Butz, Jr.

Washington—Gliders with flexible wings made of high-temperature cloth are showing increasing promise as orbital re-entry vehicles in preliminary design studies and experiments conducted at National Aeronautics and Space Administration's Langley Research Center.

Latest published information on tests with cloth wing gliders is the most optimistic in several years of experimentation with flexible lifting surfaces by a group at Langley Field headed by Francis M. Rogallo. NASA Technical Note D-443 reports on these tests.

A preliminary type investigation of these gliders at both subsonic and supersonic speeds showed their wing loadings might be kept down to less than one pound per square foot, with the result that maximum re-entry temperatures would be less than 1,500F. If wing loading is raised to about 10 psf. as for stiff-winged re-entry vehicles, then stagnation temperatures will rise to several thousand degrees Fahrenheit.

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FLIGHT TEST of flexible wing is made at Langley with radio-controlled plane model.

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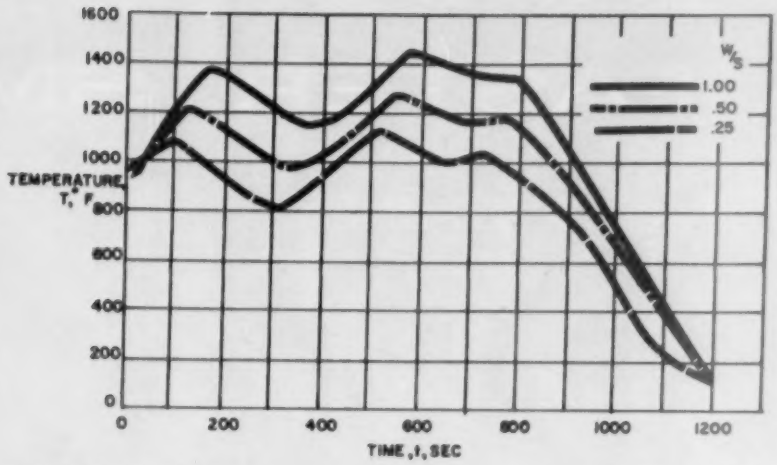


TIME HISTORY of the temperature expected during the re-entry of a flexible-wing glider is shown above for three wing loadings (w/s). Wing loading of 1 psf. is considered possible now, and advances in the techniques of weaving high-temperature glass cloth will lead toward wing loadings of much less than 1 psf., according to current estimates.

and controls problems have been found with the flexible wings. In the recent NASA report, Rogallo and three other authors, John G. Lowry, Delwin R. Croom and Robert T. Taylor, reached the following conclusion: "Results of this study indicate that this flexible-lifting-surface concept may provide a lightweight controllable paraglider for manned space vehicles."

First public discussion of the flexible re-entry gliders, which are similar to parachutes in construction, was held almost a year ago at the tri-annual inspection of the Langley Research Center.

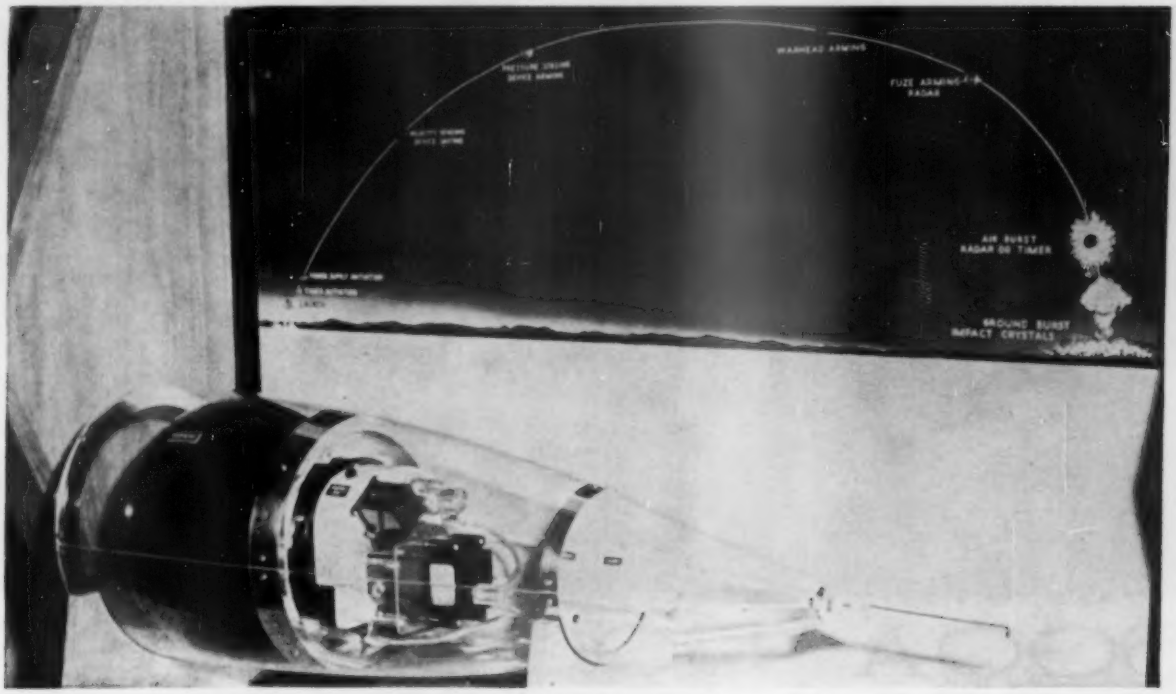
Several other uses have been proposed for flexible lifting surfaces. These are:

- **Auxiliary wing** which could be furled in a long thin container on top of a supersonic aircraft and released at low speeds to increase wing area for landing and reduce approach and touchdown speeds.
- **Auxiliary wing** to aid in the takeoff of heavily loaded aircraft. Auxiliary wings of this type could be retractable or jettisonable.
- **Recovery of large** first-stage boosters through the use of flexible wings which will fold into a small area and will not produce any lift force during launch.
- **Emergency wings** for use with vertical takeoff and landing aircraft.
- **Precision dropping** of personnel and cargo.

Key to the use of a flexible wing on re-entry vehicles is keeping weight and wing loading low. This can be accomplished with known materials primarily because the loads are all tension loads.

Light Wing

Initial estimates of the weight of a single-ply wire cloth or gauze which is practical for the wing is about 10 oz. per sq. yd. when coated with a high-temperature silicone sealant to make it non-porous. Using this value, a wing with inflated leading edges two feet in



Nuclear Warhead Model Displayed by AEC

Model missile nuclear warhead section is an idealized design, not representing any specific weapon. Designed and developed by the Atomic Energy Commission, it is safetied, armed and fired by components of an adaption kit. An inertial fuze, not shown here, uses a predetermined point in the trajectory of a missile for initiating firing. Alternatively, a radar fuze can start the firing sequence. Also available are aneroid pressure-sensing devices and crystal-impact sensing devices to initiate firing. Weapon safe devices are also used to prevent premature firing.

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diameter, inflated shroud lines and an area of 1,500 sq. ft. would weigh about 250 lb. The wing weight would go up to about 700 lb. if the area were doubled.

The potential advantage of this vehicle is that for a total gross weight of 3,000 lb. there would be 2,300 lb. available for capsule structure and crew to be carried under the flexible wing. The capsule structure to protect the crew during re-entry would be relatively light because of the low re-entry temperatures.

In contrast, a Mercury type re-entry capsule requires a gross weight of about 1,400 lb. to carry a 200-lb. man through a re-entry during which the temperatures are several times higher.

The weight advantage of the flexible wing glider is expected to improve as experience is gained in weaving high-temperature glass fibers into cloth. Glass cloth theoretically can be lighter than metal mesh in the same temperature environment.

Control of the flexible-wing gliders is effected by adjusting the length of the shroud lines. For instance, a right turn is made by reeling in the lines to the right hand side of the capsule.

Stability of the flexible gliders at supersonic speed proved to be very good. The three inflated cylinders which form the stiff keel and leading edges for the gliders did not show a tendency to flutter, and the flexible membrane between them also remained steady.

The flexible canopys of conventional parachutes at supersonic speeds have been shown to have many unsteady motions at supersonic speeds. Typical of these motions are "breathing" and "squidding" which keep the parachutes from extending fully and produce a fluctuating drag force.

Deployment

Deployment of the flexible wings at subsonic speeds has been found to be practical using several techniques, including squirting the wing out of the back of a cylinder or opening the top of the cylinder.

Lift/drag ratios for the wings have been shown to be about 1.0 in tests to date, which have not been made under optimum conditions. This figure is expected to improve, especially when cloth with less porosity is available.

Re-entry of the flexible-wing, low-wing-loading gliders into the atmosphere will occur at such a high altitude that accelerations will be very low due to the low air density. A typical re-entry might start about 400,000 ft. altitude at about 18,000 mph., and the glider with 1.0 psf. wing loading would have slowed to subsonic speed before it reached 150,000 ft. The maximum acceleration it experienced would be less than 1.7g.

Upper-Atmosphere Rocket Probe Program Accelerated at Eglin AFB

Eglin AFB, Fla.—Upper-atmosphere sounding rocket firing programs are accelerating here as USAF's Air Proving Ground Center moves deeper into utilizing its facilities and talents toward a growing space and missile mission capability.

Eglin now is the site of most USAF space probes, officials here note, backing up other Air Research and Development Command divisions, which handle long-range planning and establish the requirements to ascertain mission accomplishments. Major projects handled here are developed at Wright Air Development Division, Wright-Patterson AFB, Ohio, and a detachment of the Air Force Research Division (AFRD), L. G. Hanscom Field, Bedford, Mass. Space probe firings are conducted by APGC's High Altitude Test Vehicle Branch utilizing heavily-instrumented sites on the Eglin Gulf Test Range off the southwest Florida coast.

Rocket Firings

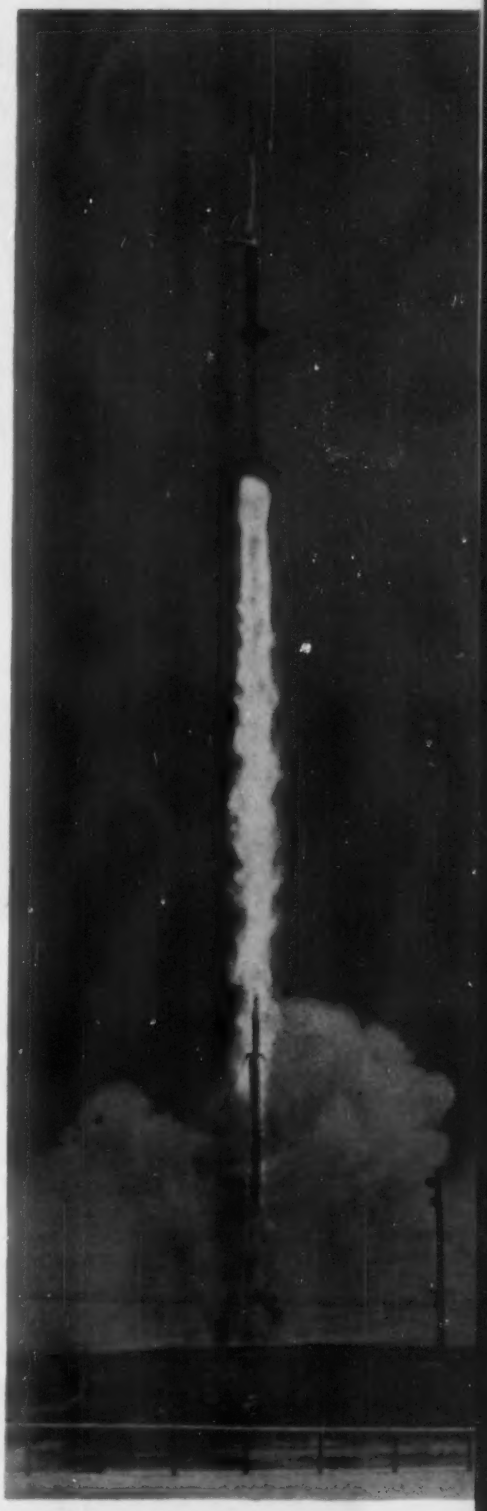
Rocket firings are conducted from Santa Rosa Island, impacting in the Gulf of Mexico from 18 to 200 mi. off the southwest Florida shore, the vehicles tracked throughout their trajectory by radar, telemetry and tracking cameras and data reduced by Eglin.

Six rocket research vehicles are carrying the bulk of sounding studies including Nike-Cajun, Nike-Asp, Aerobee 150 and 300, Cree and Exos.

Project Firefly

Nike-Cajun has been scheduled on Project Firefly, currently being carried out here to gather data on artificial ionized clouds created by the release of chemicals or detonation of explosives at high altitudes to study long-range communication capabilities, infrared phenomena and the physics of the upper atmosphere as affected by this artificial disturbance. The Nike-Cajun is fired some 160 mi. high to create a point electron cloud—a charge of ammonium—and 20 sec. later, a Nike-Asp is fired through the cloud. Nike-Asp carries a 70-lb. payload of sensitive elements, exposed by releasing the nose of the rocket during ascent. Data obtained is telemetered to the ground. Among the objectives of these studies, involving 33 firings, have been data on the plasma sheath that sometimes builds up on missiles and causes communications blackouts.

Another test conducted with the Nike-Cajun has been an effort to determine the flux density of micrometeor-



NIKE-ASP space probe is launched from Eglin Gulf Test Range, Fla.

THE PROBLEM SOLVERS

Rockets to probe the Van Allen belt

Aerolab engineer checks guidance fins for the ARGO D-8 rocket that will boost a nuclear emulsion recovery vehicle (NERV) to 1500 miles altitude to study the Van Allen radiation belt. As prime contractor to NASA, Aerolab engineers must also plot precisely the ballistic trajectory and impact point of this unguided rocket so that the nose cone may be recovered from the ocean 1700 miles down the Pacific Missile Range.

Aerolab has developed more space probes and rocket-powered research models, including the Mercury capsule model, which have been fired, than any other firm in the United States.

Currently, Aerolab, a wholly-owned subsidiary of Ryan Aeronautical Company, is developing instrumentation packages, attitude and stability controls for payload packages, particle collectors, payload recovery systems, antenna arrangements, and nose cone separation devices.

Thus, from the complete package in which Aerolab has cognizance for the entire program, to the provision of advanced components, the problem solvers at Aerolab have capabilities in aerophysics *beyond the usual.*

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ites existing in the fringes of space. The impact of this space dust is recorded, using small microphones placed under a thin metallic skin on the nose cone, and the impact signals are transmitted to ground recording stations on the Eglin Gulf Test Range.

Nike-Asp has also been utilized on several launchings to 160 mi. to provide data on the physics and composition of space in connection with manned space programs. At least three of these vehicles have been launched since last November for this study.

Aerobee 150s have been sent 160 mi. up to measure high-altitude radiation and infrared radiation phenomena at these heights. Aerobee 300s have been used in Project Tattletale, a test to determine feasibility of a positive communication system. The missiles are sent some 250 mi. up and a transmitter is keyed to flash a coded message on a UHF radio to determine range capabilities at these heights. Other Aerobee 300s are used in ionosphere projects similar to those handled by the 150s.

Cree Rockets

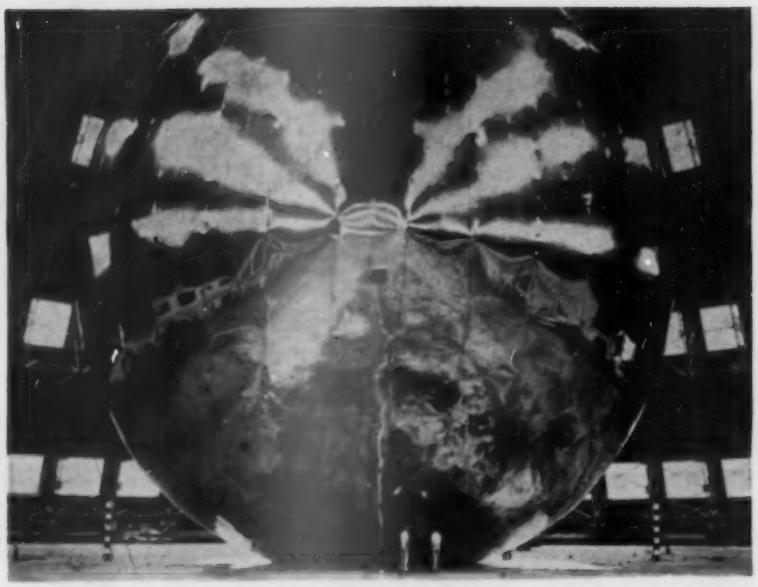
Cree rockets, which have a capability of taking an 800-lb. payload to 20-mi. heights at Mach 2 speeds, have been carrying special nose cones, escape capsules and atmospheric re-entry devices to support future WADD man-in-space projects. A series of 18 Cree shots have been scheduled for these studies and one nose cone was successfully recovered from Gulf waters 18 mi. offshore from a depth of 120 ft.

Exos is the largest of the high-altitude research vehicles worked here. A 42-ft. high, three-ton vehicle, Exos carries a 100-lb. payload to 230 mi. altitude and impacts some 200 mi. downrange into the Gulf. This vehicle is being employed to measure cosmic ray flux density between sea level and satellite operating altitudes.

Courier IB Launch Set

Washington—Army's Courier IB experimental communications satellite is scheduled to be launched Oct. 4. Recent attempt to launch Courier IA was unsuccessful because of a hydraulic system failure and subsequent control malfunction in the first stage of the Thor Able-Star launching vehicle.

Program management for the Able-Star second stage will shift from Space Technology Laboratories, Inc., to Aerojet-General Corp. with this launching. Space Electronics Corp., as major subcontractor to Aerojet for the stage, will service electrical systems. STL continues as systems engineer and technical director for the over-all project and furnishes the guidance system.



NASA Ground-Tests Inflatable Satellite

National Aeronautics and Space Administration 100-ft.-dia. spherical satellite is inflated with 40,000 lb. of air during ground test. Echo I orbiting satellite (AW Aug. 22, p. 30) was inflated after injection into orbit by expansion of residual air, 10 lb. of benzoic acid and 20 lb. of anthraquinone, both sublimating powders. Only a few pounds of pressure are required to keep Echo I inflated during orbit. The gas is believed to be escaping through punctures made by micrometeorites and through 242 venting holes, causing wrinkling of the aluminum-coated plastic skin (AW Sept. 12, p. 34).

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Photo courtesy of Douglas Aircraft Company

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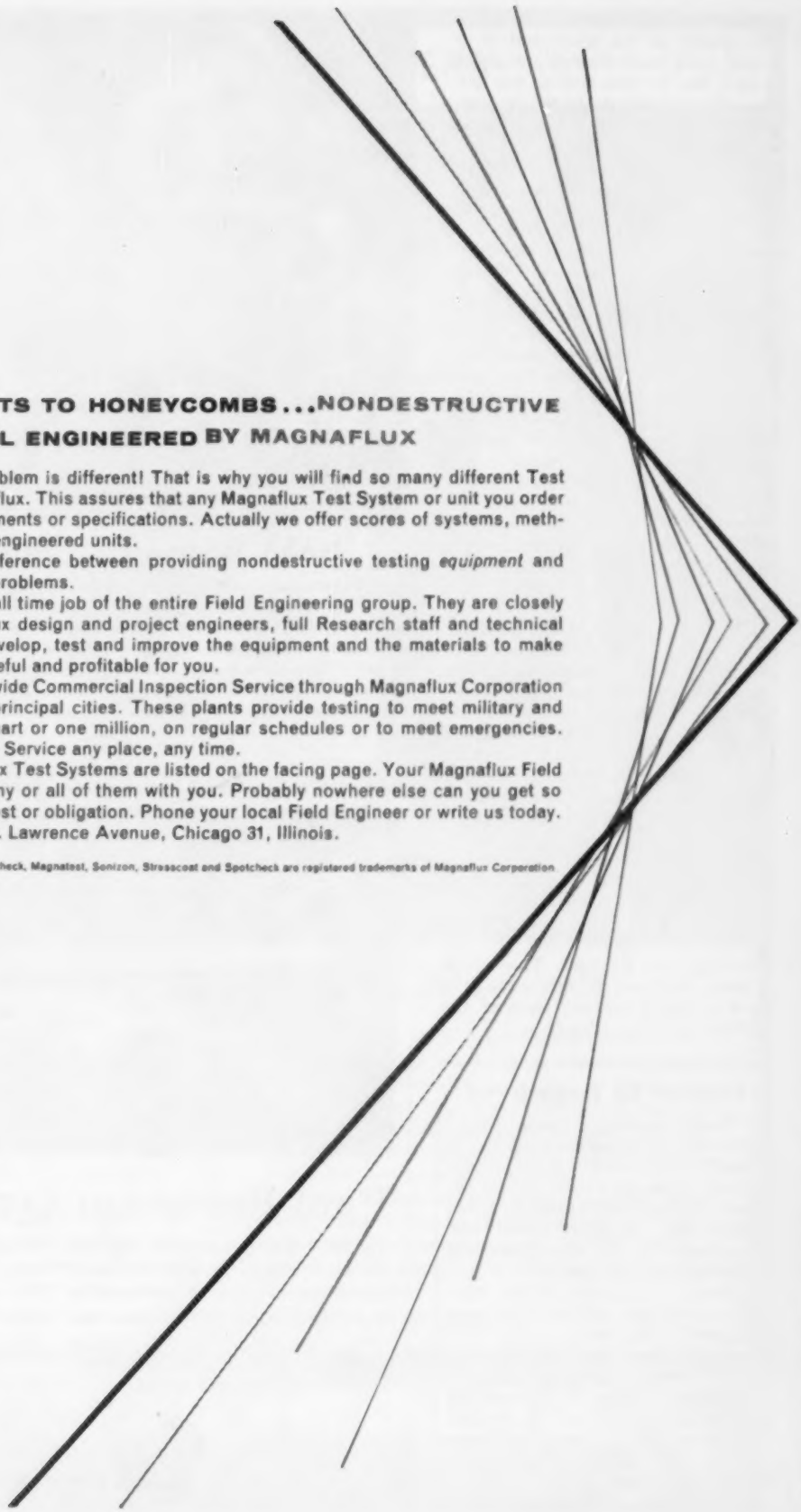

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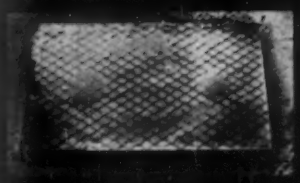

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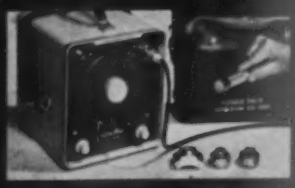

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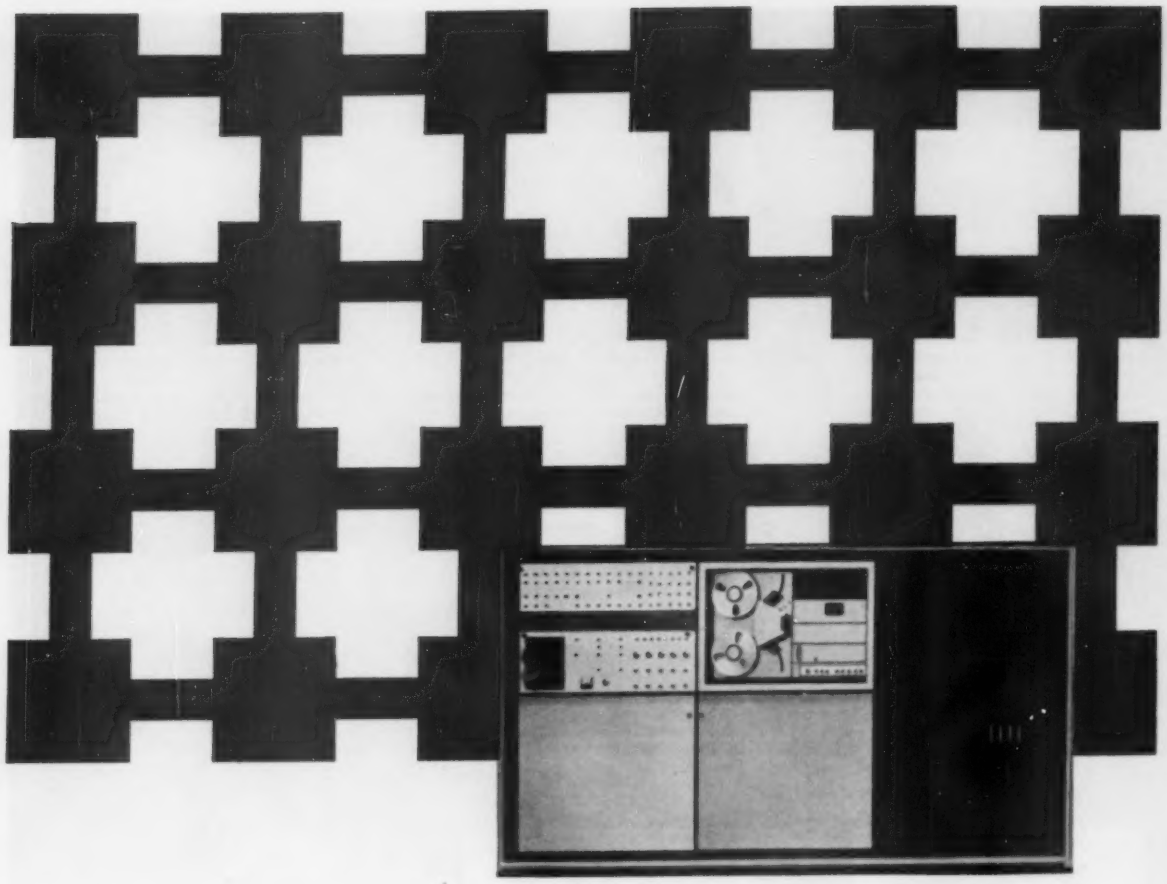

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Soviets Decline Posts in Space Academy

By Evert Clark

Stockholm—International Academy of Astronautics has begun its first year of operation with an initial membership of 43 scientists, engineers and lawyers from 14 nations, but with Soviet Russia —one of the two leaders in the space field—still declining to participate.

Vacancies are being held open for nine Russian scientists nominated by the founding committee in the hope that the Soviet government might approve of their participation if world tensions are eased.

Eleven U.S. scientists and engineers and two attorneys who have specialized in space law are included in the initial membership, which eventually will grow to 165.

Creation of an academy to consist of "individuals who have distinguished themselves in one of the fields of astronautics or one of the branches of all sciences of fundamental importance for the exploration of space" was proposed by the governing council of the 29-nation International Astronautical Federation at its 10th annual congress in London last year.

Dr. Theodore von Karman was named chairman of a founding committee and empowered to choose its members. Although nationality is not supposed to be a consideration in selecting academy members, Russia has indicated that strong U.S. interest in and possible domination of the academy might be its real reason for refusing the nine memberships. Russia has openly declared itself in favor of giving stronger positions to the nations which are leading in space exploration and made this an issue at the recent 11th annual IAF congress here.

Committee Composition

Prof. Leonid I. Sedov, who was reelected president of the IAF at this congress, was a member of Dr. von Karman's founding committee by virtue of his presidency during the past year. Since Russia has raised the question of nationality, makeup of the 23-man founding committee by national identification is interesting—eight from the U.S., including von Karman; three each from France and Germany; two each from England and Italy, and one each from Russia, Belgium, Argentina, Czechoslovakia and Switzerland.

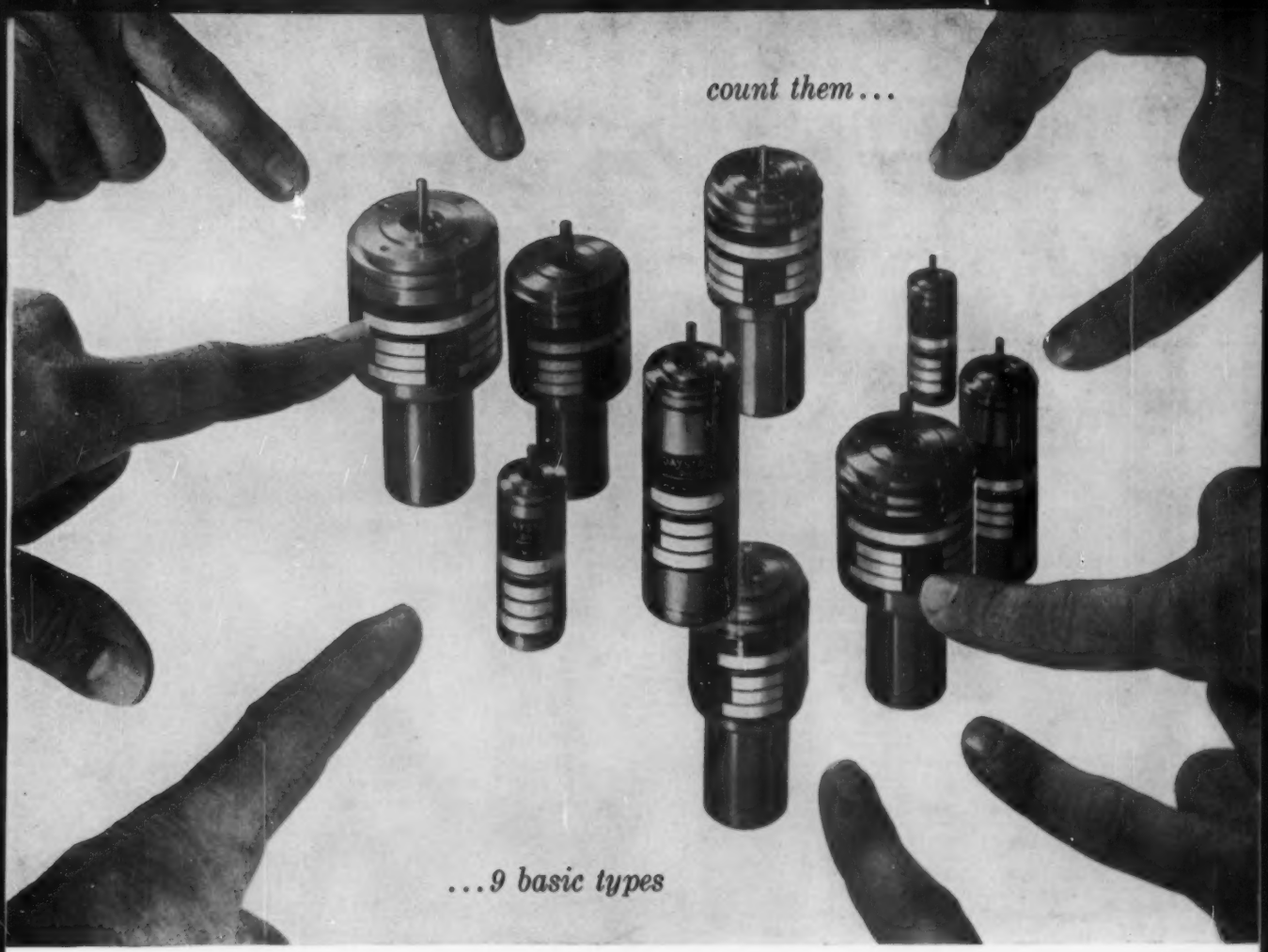
When the academy held its first special meeting in conjunction with the IAF congress here, names of the 43 initial members were revealed. This group does not include Krassovsky, Vernov, Ogorodnikov, Blagonravov, Sedov, Nesmeyanov, Topchiev, Kuznetsov or Sesakian of Russia or Prof. Harrie S. W. Massey of England, who also declined a seat.

By nationality, the 43 who accepted seats break down to—U.S. 13; France 6; Germany 5; England 4; Belgium 3; Italy 3; Czechoslovakia 2; and one each for Sweden, Bulgaria, Switzerland, Netherlands, Argentina, Yugoslavia and Canada.

Aside from numbers and nationalities, there is no doubt that U.S. members have constituted the strongest single force behind the conception and organization of the academy. Among the most instrumental was Andrew G. Haley, Washington attorney, general counsel of IAF and a former IAF president. Haley is said to have enlisted the aid of Dr. von Karman, who in

Model Shows Layout of Mercury Control Room

Project Mercury control center to be constructed at Cape Canaveral, Fla., is shown in scale model. Wall map, 26 ft. x 8 ft., is being built by Stromberg-Carlson, San Diego, Calif. Map will show position of orbiting capsule; displays along top of map will indicate number of orbit and significant flight event time. Charts flanking map will show status of primary capsule systems and condition of pilot.



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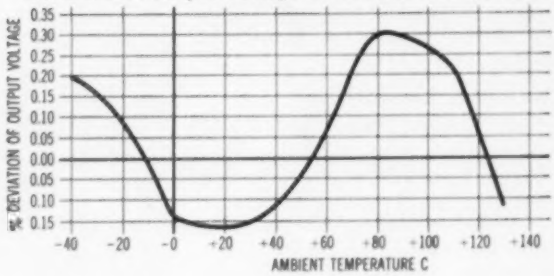

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turn has arranged for a $75,000, three-year grant from the Daniel and Florence Guggenheim Foundation to permit the academy to employ a staff and begin its work.

Academy Staff

Von Karman has been named director of the academy, with Prof. J. Peres and Dr. Frank J. Malina, both of France, as deputies. A. R. Weiller of France is acting secretary. The academy will share temporary offices with the IAF at 12 Rue de Gramont in Paris.

To begin its first year, the academy:

- **Created** a Guggenheim International Astronautics Award, not to exceed $1,000, to be awarded for outstanding contributions in the five previous years.
- **Created** an International Lunar Laboratory Committee to study the question of need for such a laboratory and the types of research to be done in it.
- **Decided to elect** more members next December to bring the academy to about two-thirds of full membership.
- **Created a joint** committee on space law with the International Institute of Space Law, a body which also was proposed by the IAF at the London congress. Prof. John Cobb Cooper is committee chairman.
- **Prepared to plan** special symposia, both in conjunction with IAF congresses and separately if desired.
- **Proposed asking** the United Nations Economic, Social and Cultural Organization (UNESCO) for a grant in 1961-1962, part of which would be used for a preliminary study group to determine desirability and feasibility of holding a symposium in 1963 on the problems of man in space.
- **Planned to publish** a journal to supplement national journals in the space field.
- **Planned to take** over from the IAF preparation of a handbook in several languages of space research terms. IAF has asked UNESCO for financial help with this project.
- **Suggested that IAF,** which has cooperative arrangements with the UN, UNESCO and the International Telecommunications Union, make similar agreements with the World Meteorological Organization, World Health Organization and International Atomic Energy Agency; and proposed that the academy explore the best means for cooperating with the International Council of Scientific Unions, Council for International Organization of the Medical Sciences and Union of International Engineering Organizations.

Academy membership is divided into three groups—basic sciences, applied sciences and life sciences. Original 43 members are:

- **Basic sciences.** Prof. H. O. G. Alfven,

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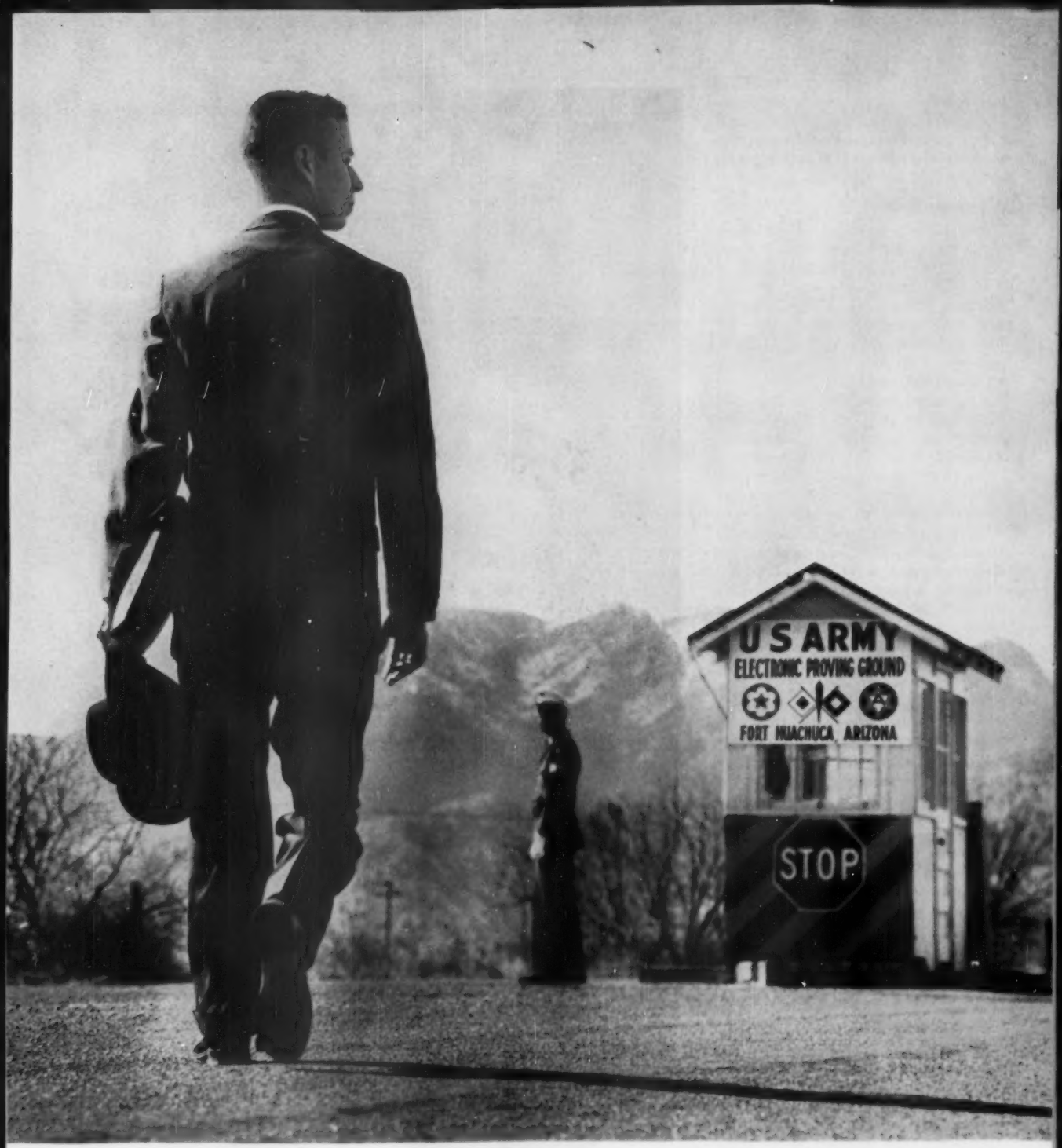

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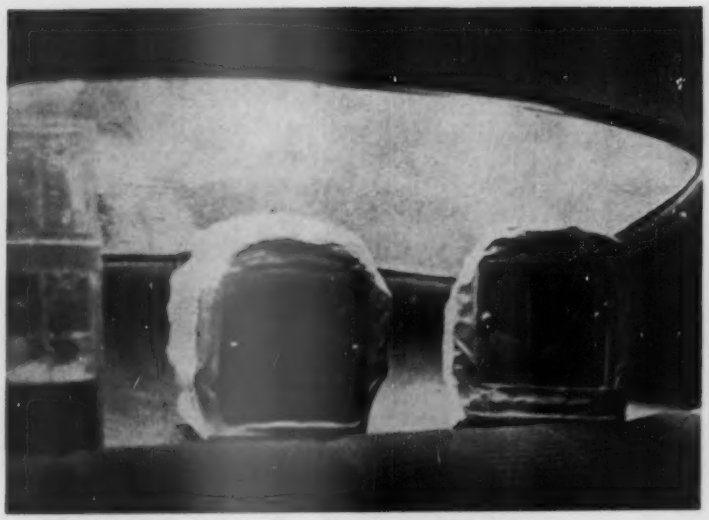


Soviets Exhibit Payload Recovered From Sputnik V

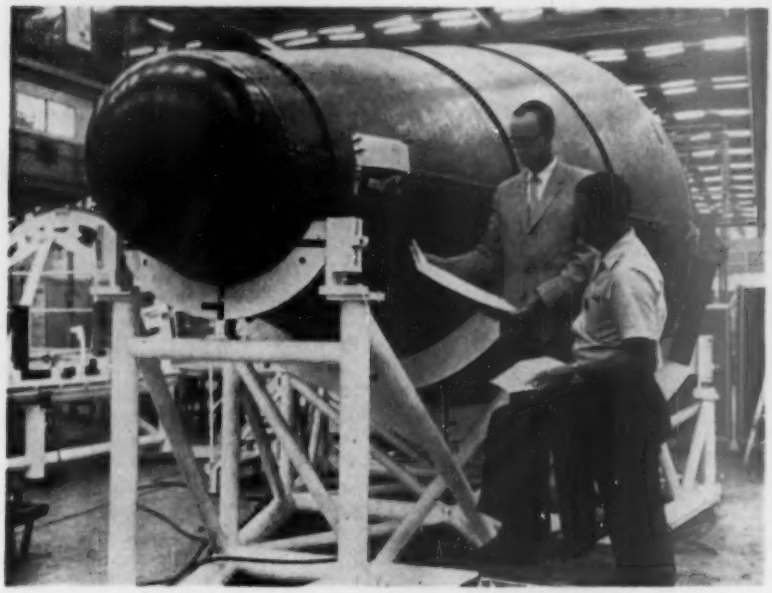
Soviet dog Belka is exhibited in a Moscow radio station after returning to earth in a capsule recovered from Sputnik V (AW Aug. 29, p. 28). Containers at right hold rats, mice and a vessel with plants which also were orbited in the satellite.

Sweden; Prof. P. Auger, France; Prof. Nicolas Boneff, Bulgaria; Dr. J. G. Davies, England; Prof. Alfred Ehmert, Germany; Prof. Vladimir Guth, Czechoslovakia; Dr. Joseph Kaplan, U.S.; Prof. A. C. B. Lovell, England; Prof. M. Nicolet, Belgium; Prof. J. Peres, France; Dr. Irene Sanger-Bredt, Germany; Dr. Lyman Spitzer, Jr., U.S.; Prof. H. C. Urey, U.S.; Dr. J. A. Van Allen, U.S.

• **Applied sciences.** Prof. J. Ackeret, Switzerland; Dr. Wernher von Braun, U.S.; Prof. L. Broglio, Italy; Prof. E. A. Brun, France; A. V. Cleaver, England; Prof. G. A. Crocco, Italy; Dr. Hugh L. Dryden, U.S.; Prof. A. Eula, Italy; Dr. Theodore von Karman, U.S.; Prof. J. M. J. Kooy, the Netherlands; Prof. L. Malavard, France; Dr. Frank J. Malina, France; Dr. Hermann Oberth, Germany; Prof. R. Pesek, Czechoslovakia; Dr. William H. Pickering, U.S.; Dr. Eugen Sanger, Germany; Dr. L. R. Shepherd, England; Prof. Teofilo M. Tabanera, Argentina.

• **Life sciences.** Prof. R. K. Andjus, Yugoslavia; Gen. P. M. Bergeron, France; Prof. J. C. Cooper, U.S.; Dr. E. Evrard, Belgium; Brig. Gen. Don Flickinger, U.S.; Prof. M. Florkin, Belgium; Prof. W. R. Franks, Canada; Andrew Haley, U.S.; Dr. W. Randolph Lovelace II, U.S.; Prof. Alex Meyer, Germany and Dr. Hubertus Strughold, U.S.

Membership of 165 will be divided 60 each for basic and applied sciences, 45 for life sciences.



Convair-Ft. Worth Builds Centaur Nose Cones

First nose cone for Centaur, built entirely of reinforced plastic material and designed to shield payload during ascent, has been completed by Convair-Ft. Worth and will be shipped to Convair-Astronautics, San Diego, for ground tests. Later cones built at Convair-Ft. Worth will go directly to Cape Canaveral, Fla., where Atlas-Centaur launchings are scheduled to begin next year. Cone is of glass fiber sandwich construction comprising a honeycomb core bonded between layers of glass-reinforced plastic. Nose cone will be jettisoned in space.

GE Tests Spacecraft Fuselage Protection

Washington—General Electric research project indicates spacecraft built of multi-wall construction can save more than 50% in weight and provide the same protection against meteoroids as single, solid walls.

After 352 pellet firings simulating micrometeorite impacts at velocities up to 12,800 mph., GE Missile and Space Vehicle Dept. has determined that thick aluminum, steel and magnesium "bumper" shields effectively dissipate much of the pellet energy, resulting in only mild pitting of the vehicle's pressure hull. Pellets, made of aluminum, steel and titanium, ranged in size from one-eighth to one-half inch. Multi-wall construction involves layers of metal walls separated by air insulation. Company-funded program cost $40,000.

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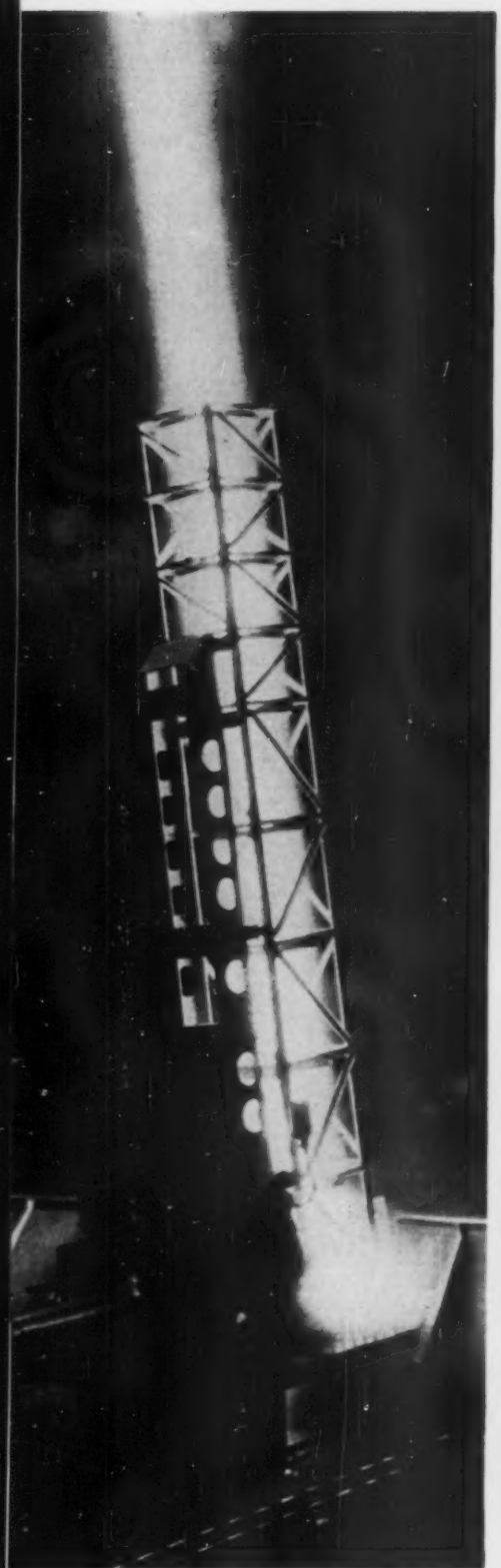
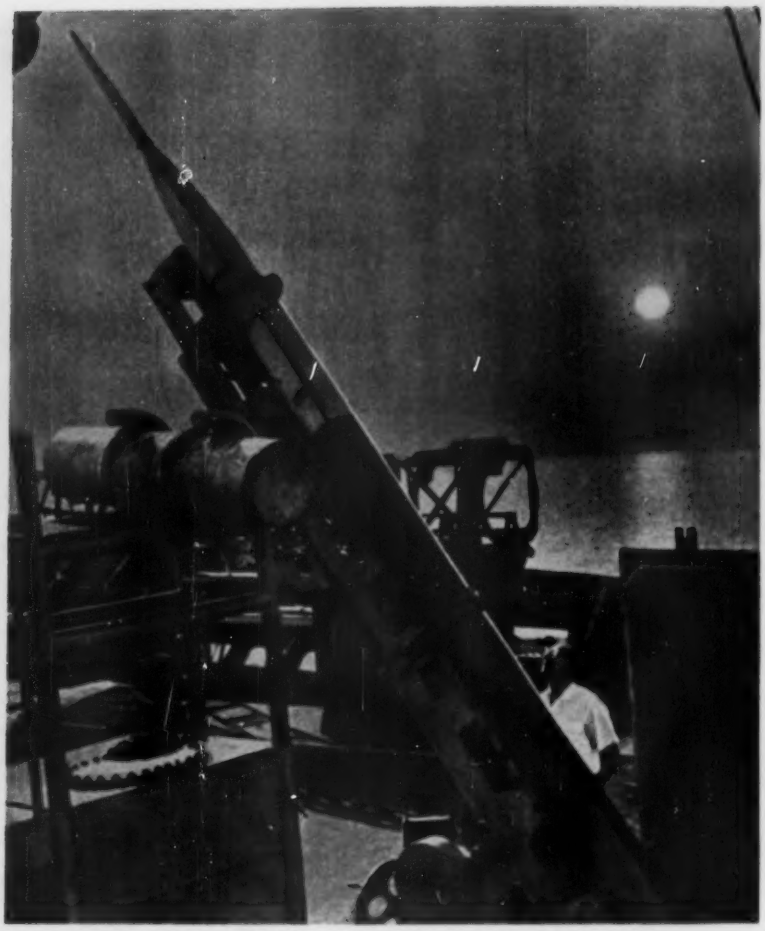
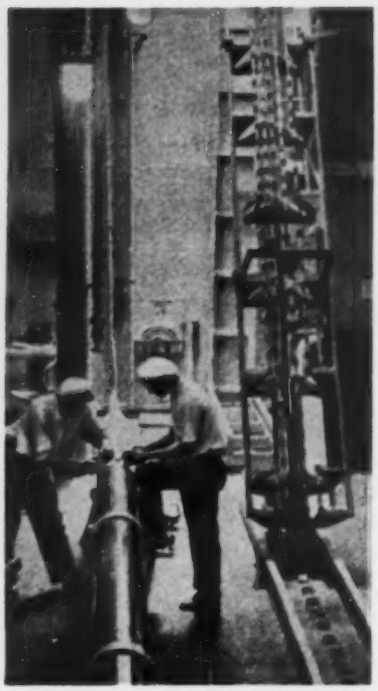


Night launching of a meteorological rocket from the deck of the new Russian scientific-research ship Shokalsky is seen above. At right technicians work in ship's rocket hold.

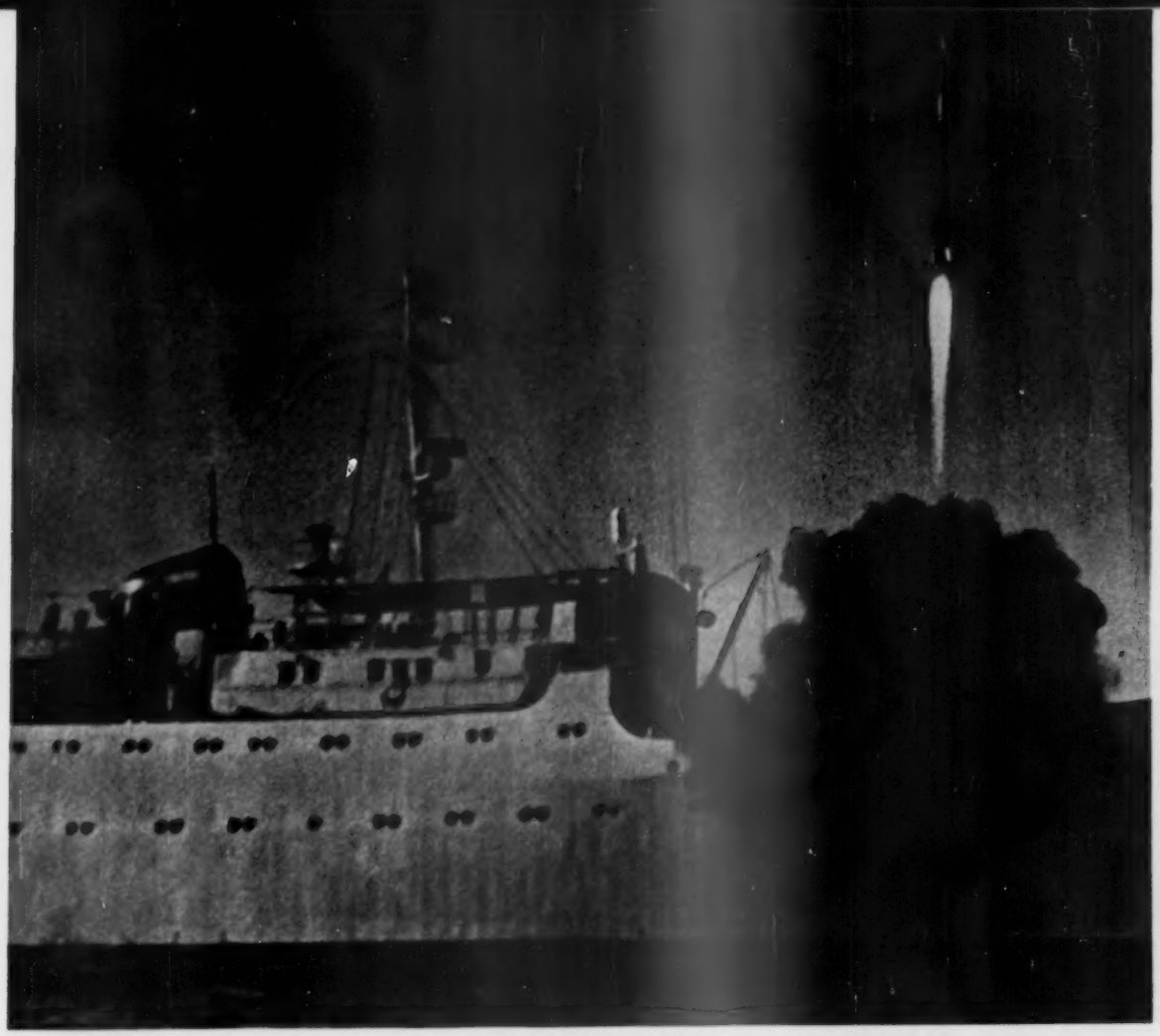


Meteorological rocket is raised to forward deck from rocket hold of Shokalsky.



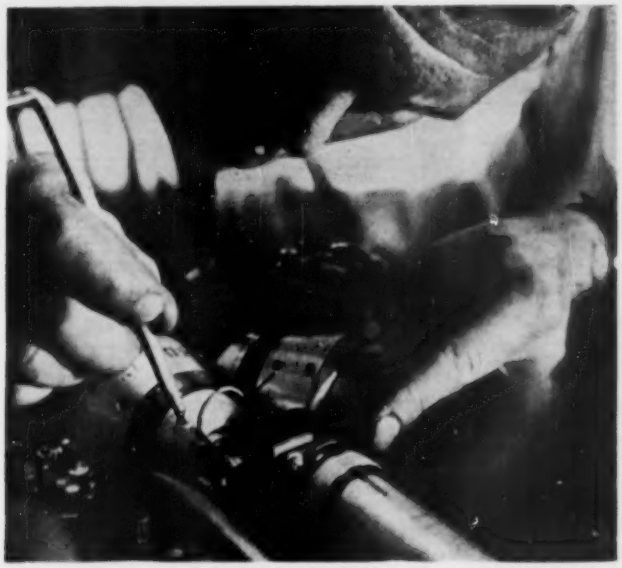
Weather Rockets

New Soviet meteorological rocket-firing scientific-research ship Shokalsky has a displacement of 3,600 register tons, a speed of 13 mph., and extended range which permits the ship to remain at sea for 120 days. Rockets are carried in a hold beneath the forward deck. Instrumented nose section is attached before rocket is raised to the deck through a special hatch. According to the Soviets, the Shokalsky will "systematically measure the radioactivity of the air, precipitation and sea water." The ship is scheduled to go to Vladivostok before heading out to sea for its extended voyage in the Pacific. Russia has fired research rockets from aboard ship near the Soviet Mirny observatory in the Antarctic, in equatorial latitudes and in northern parts of the Pacific. It is believed that previous rockets were not stored and run up through the deck as is done on the Shokalsky. The Soviet rockets are fired to study pressure, temperature and solar radiation effects, and reportedly reach an altitude of 50 mi.



A meteorological rocket is launched from the Soviet scientific-research ship Shokalsky (AW July 25, p. 23).

Launched From Soviet Scientific-Research Ship



Engineer completes assembly of control unit (left) and technicians check instruments in the nose section of meteorological rocket (right).

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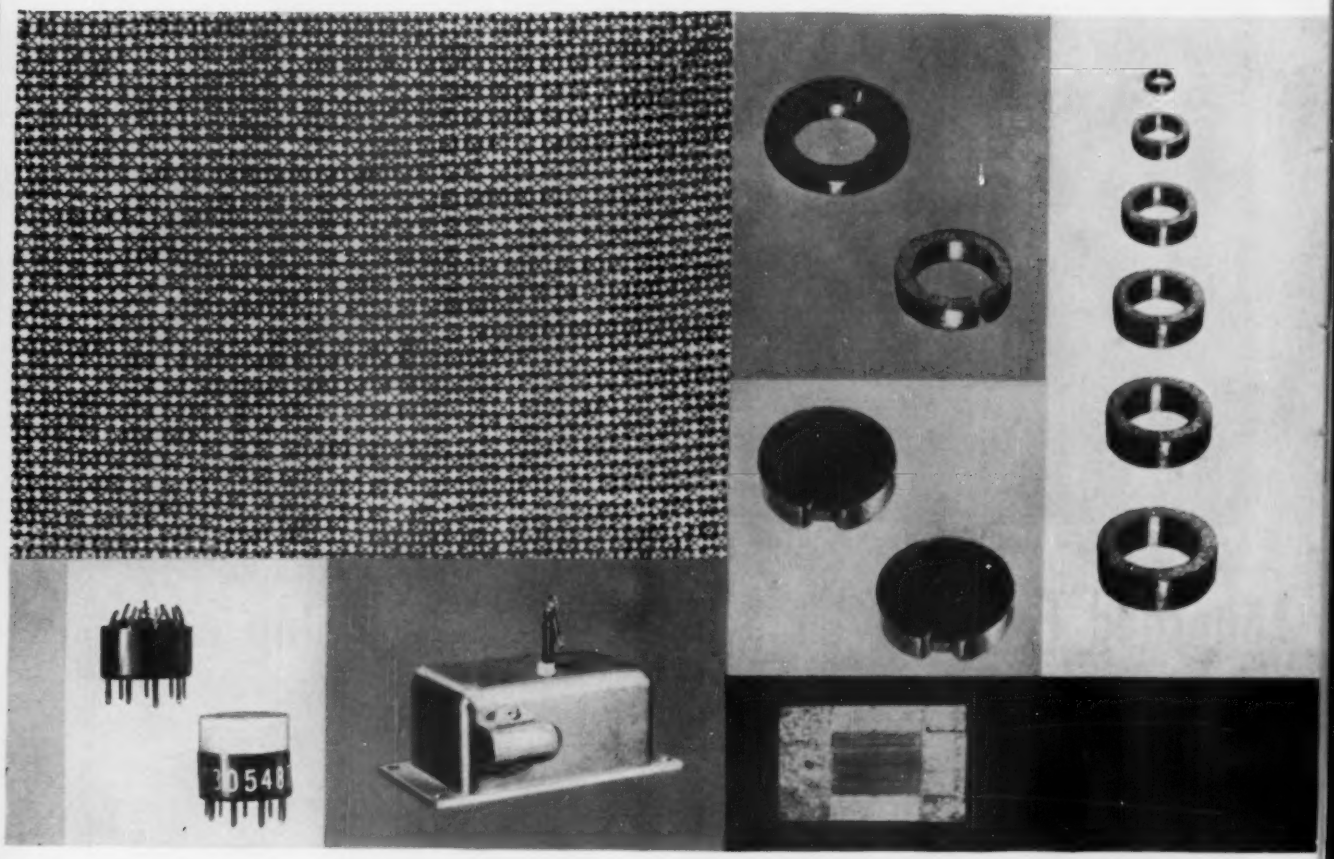

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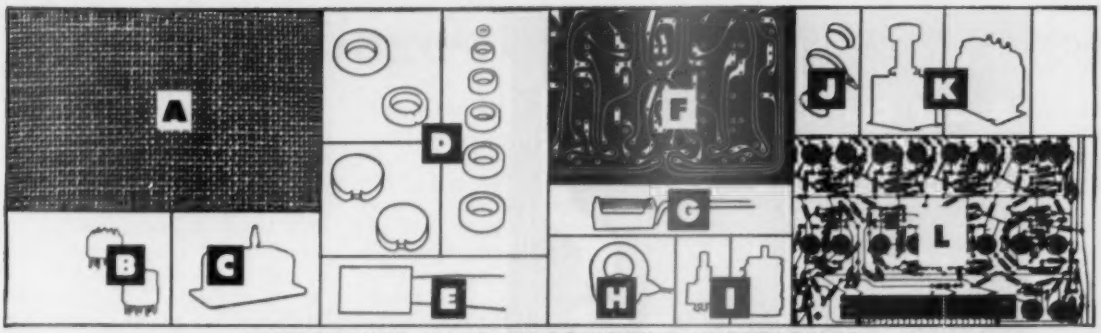

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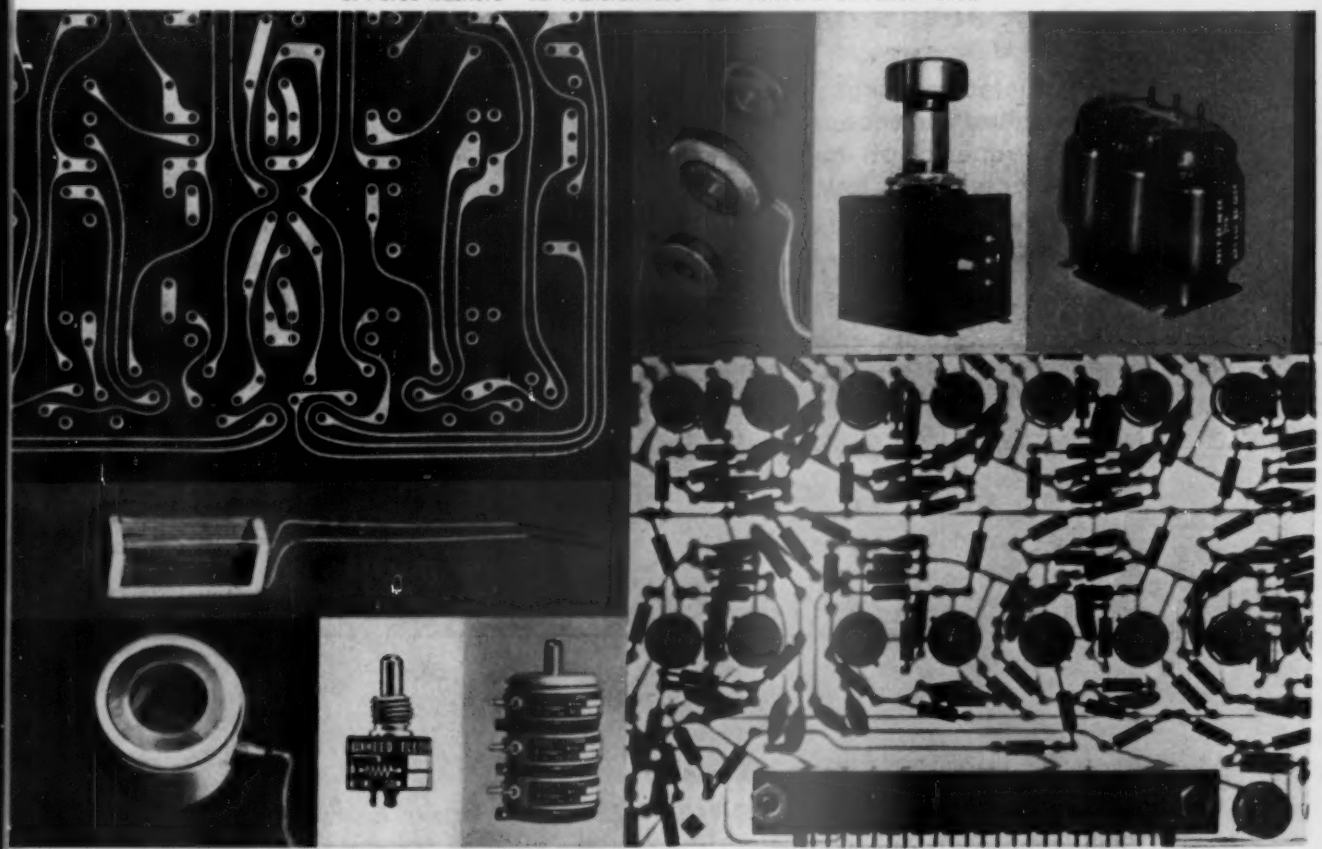

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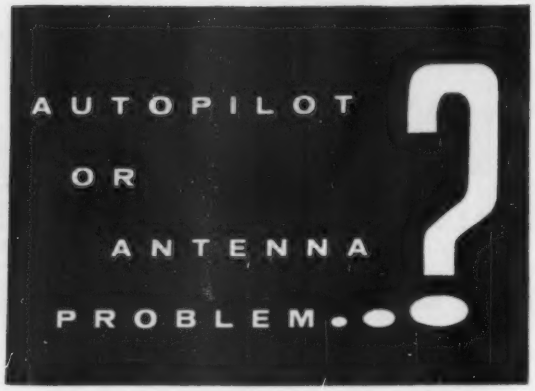

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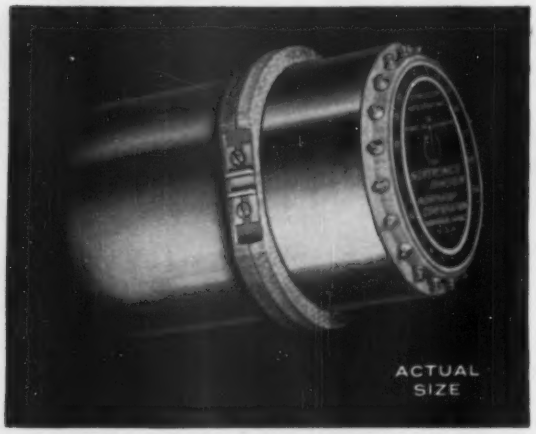

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Symposium Gages Life Support Progress

By Russell Hawkes

Los Angeles—The 15% increase in the U.S. investment in tracking stations, data processing centers and launch facilities funded in Fiscal 1961 for space programs was called the beginning of a vast expansion in ground facilities by NASA Administrator T. Keith Glennan, at the Fifth Ballistic Missile and Space Technology Symposium, here.

The three-day symposium was attended by 800 people from industry and the military services. It was sponsored by Air Force Ballistic Missile Division, Space Technology Laboratories, Inc., and Aerospace Corp.

Reliability Problems

Unusual reliability problems for closed cycle ecological systems were outlined by D. F. Mitchell of Northrop Corp. Though a culture of living organisms will not wear out like a mechanical system, it is possible for the characteristics of the organisms to change by genetic evolution so as to upset the balance of the ecological cycle. The useful qualities of the organism might disappear completely or the cultures might become so inefficient in regenerating oxygen, food and water that human life would be impossible.

Biological cultures in such a system can also be destroyed by poor detail engineering. Algae are poisoned by several common materials, such as brass. If corrosion penetrated the plating on a brass fitting in an algae tank, the culture, and eventually the crew, would die.

Mitchell suggested that reserve cultures might be carried for reinoculation of the system if the original cultures are modified by evolution or destroyed in some other way. However, reserves might undergo the same changes as the main cultures.

He said it is mandatory that the life support system be designed to encourage stability of the culture by aiding natural selection of organisms with the desired characteristics and that the algae be carefully chosen and if necessary modified in the laboratory to improve their value in a stable system.

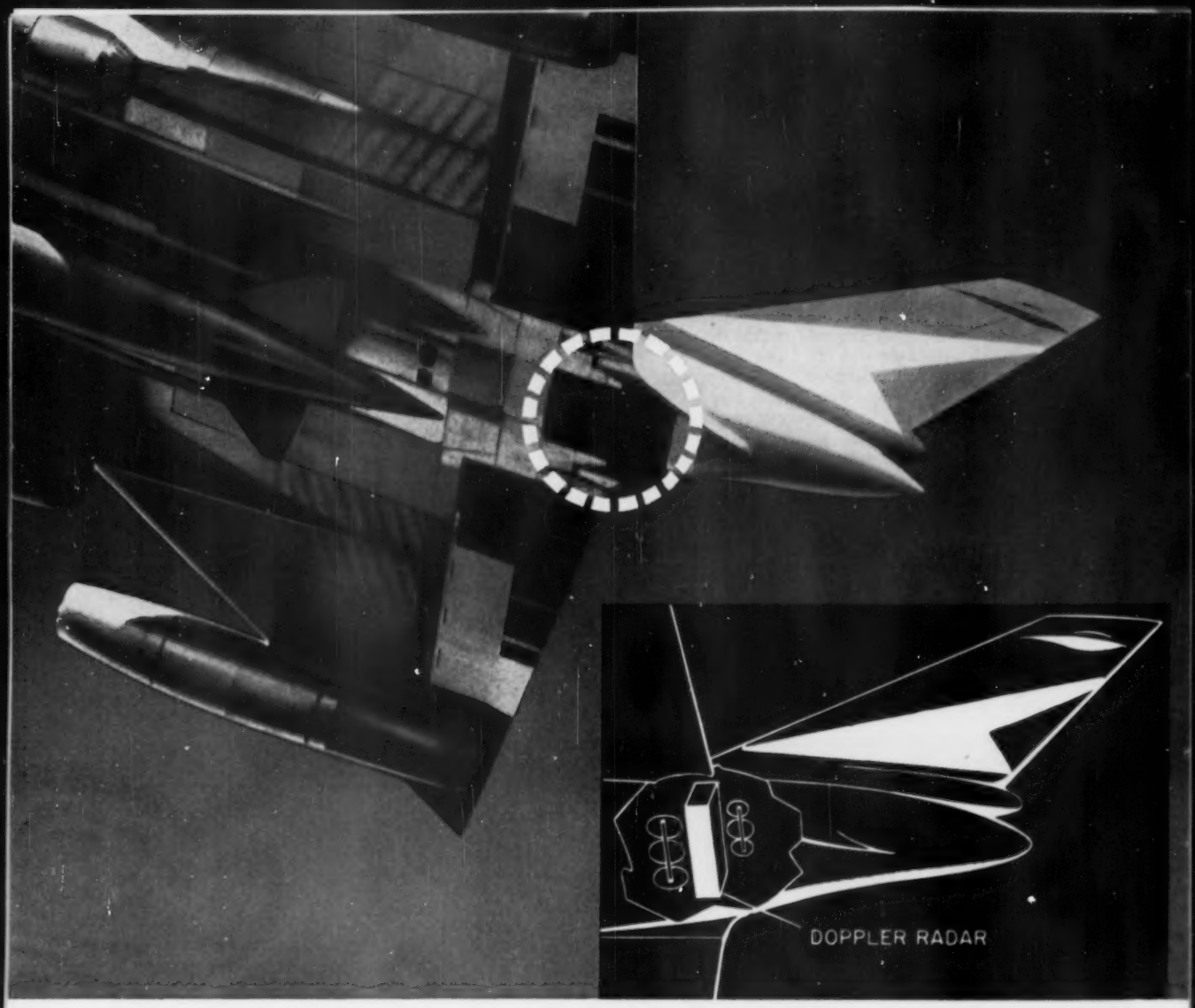
Impact Shock

There is as yet no practical method of impact attenuation which will give adequate protection to astronauts being returned to earth by a parachute recovery system, according to James W. Brinkley of Wright Air Development Division. Brinkley was reporting the results of 80 human subject experiments conducted at the WADD inclined test facility with impact velocities up to 30 fps., accelerations up to 54.5g and onset rates up to 17,300g per second.

Brinkley said the landing impact problem with the parachute recovery technique was underestimated in early design studies, probably because of complications produced by wind drift,

B-52G Crew Suited for High Altitude

Six-man Boeing-Wichita B-52G civilian experimental flight crew lines up wearing MC-3 pressure suits prior to boarding the missile platform bomber for a high-altitude test flight exceeding 50,000 ft. The 488,000-lb. Strategic Air Command bombers have been flown to altitudes exceeding 59,000 ft. Last B-52G on order by SAC has moved off Boeing assembly line.



Put a Doppler here? Raytheon did!

Located in the tail section of the Convair B-58 Hustler, Raytheon's Doppler radar is subject to all the following: transonic and supersonic shock waves, intense tail-pipe and skin friction heat, turbulence from the pod, extreme vibration and acoustic noise levels, and very high altitudes.

Despite this environment, Raytheon's Doppler radar meets SAC's stringent accuracy requirements. It is boresighted on the ground, eliminating in-flight calibration, and is a prime sensor to Sperry Gyroscope Company's Bomb-Navigation System.

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parachute oscillations, lack of directional control and inability to choose impact site. The effects of these appear to have been neglected and design requirements appear to have been set by vertical descent velocity, which may be less than some of those produced by the complicating factors.

Acceleration Protection

A method of handling these multidirectional impact velocities was called essential to development of escape and re-entry capsules. Since the human occupant is placed in a position to give him maximum protection against accelerations in one direction, he is in a potentially dangerous position to withstand accelerations in other directions. Air bag decelerators were called inadequate because horizontal velocities of more than 25 fps. tend to shear the bag out from under the vehicle or to make the vehicle topple.

In the WADD experiments cited by Brinkley, six paper honeycomb impact attenuator designs with different surface areas and potential crush distances were used. An undesirable characteristic of the honeycomb attenuators has been a short duration initial peak in the acceleration profile. It is apparently caused by the initial force required to start the crush of the honeycomb material. The magnitude of the initial peak has been cut by pre-crushing the honeycomb slightly.

The standard lap belt and shoulder harness were used in the experiments, but it was soon found that additional restraint was needed to prevent the head and legs of the human subject from rebounding and thus amplifying their accelerative responses.

Body Support

Two types of body support are being investigated in the WADD research program. One is the relatively familiar contoured couch of rigid urethane foam which is cast from molds that are individually fitted to each subject. The other is a rubber-covered mattress of minute, hollow, urea formaldehyde spheres, trade-named Micro-Balloons. At normal atmospheric pressure, the mattress is soft and can be shaped by the occupant to the desired contour, but when connected to a vacuum source, it becomes rigid and the contour of the occupant is retained. The mattress can be vented to remove one contour and then evacuated again to fix a new one. By this method it can be readjusted to be more comfortable during countdown, orbit, etc. Until the Micro-Balloon mattress was tried, comfort and the safety of rigid contouring had been considered incompatible.

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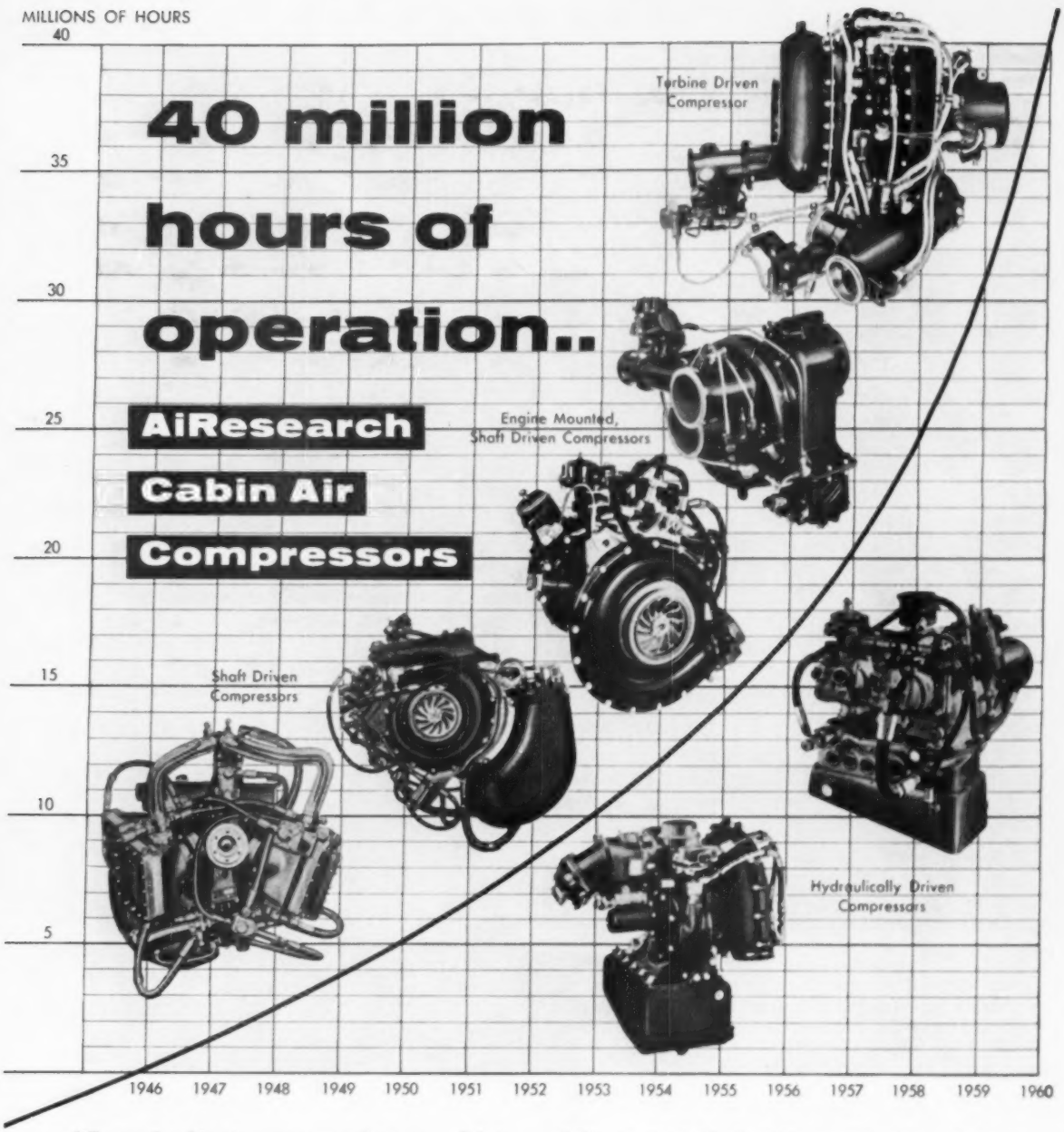

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direct current electrical system and a sealed hydraulic system without ground components, Dale Goodson of Martin-Denver reported in one of the technical meetings. The changes will cut down the number of umbilical lines and ground units.

AEC Reduces Limits On Radiation Exposure

Washington—Maximum yearly radiation exposure limit for atomic energy workers has been reduced two-thirds by the Atomic Energy Commission so that it is now equal to the yearly limit which the National Aeronautics and Space Administration has adopted for the crewmen of space vehicles.

Beginning Jan. 1, the AEC exposure limits will be 5 REM (Roentgen equivalent man, a measure of absorbed energy) per year as compared with the current exposure regulations which allow 0.3 REM per week and 15 REM per year without further restrictions as to accumulated dose.

Preliminary design specifications for NASA space vehicles call for maximum radiation dosages of 0.3 REM per week, 5 REM per year and 25 REM in a lifetime. These specifications are in agreement with the recommendations of the National Committee on Radiation Protection and published by the National Bureau of Standards.

Increased conservatism regarding radiation exposure is attributed by the AEC to a desire to bring radiation standards into accord with the latest trends in scientific opinion and "to reflect awareness of the probability of a large future increase in radiation uses."

Final decisions regarding the radiation exposure limits for military air crewmen and astronauts are still in abeyance, however. The current limits will place almost insurmountable handicaps upon vehicle designers because of the great shielding weight required to bring crew environments down to the prescribed radiation level. Air Force is now using a maximum yearly radiation dose of about 20 REM per year and 200 REM per lifetime in the preliminary design of nuclear powered aircraft. Crew flight time in these studies, however, is 1,000 hours per year, and this could be reduced to bring the yearly dose in line with the new AEC regulations.

Present dosage limits are expected to be used in design work for some time, but studies to more precisely define the biological effects of radiation, the radiation level at high altitude and in space are being pursued by the Air Force, NASA and the AEC to reconcile widely divergent scientific opinions.

Fall Firing Set for Ozone Testing Rockets

Washington—Simultaneous firing of upper air ozone sampling rockets from widely separated points in the Pacific will begin this fall.

Project, named Ozare, will use Arcas rockets and will take advantage of the ease of detection of ozone at altitudes up to 45 mi. to trace large-scale air circulation over half the earth's surface.

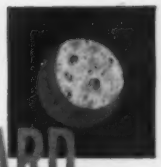
Launch sites will be Eniwetok Atoll and the Hawaiian island of Kauai. In addition to air circulation, the composition of the upper atmosphere will be analyzed by measuring ozone concentration.

On reaching a height of 45 mi., the single-stage solid propellant rocket and the nose cone will be separated and the instruments lowered by a 15 ft. parachute which is coated with a thin layer of silver to make radar tracking more efficient.

Measurements will be transmitted to the ground, while surface radar will record drift data.

Sponsor is the Office of Naval Research.

Project will be supported by the Pacific Missile Range.



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PROBLEMATICAL RECREATIONS 32

A rich farmer had 15 children by his first wife and 15 by his second. The second wife wished to insure the heritage to one of her own children and persuaded him to seat all 30 in a circle and count off every tenth child until only 1 remained. The first 14 thus eliminated were all his first wife's children. From this point on he insisted that they count backward from his first wife's lone remaining child. In what order were his first wife's children? Who became heir?

—California Engineer

Our Westrex Division has placed in a hermetically-sealed cylindrical case 3" high x 4" in diameter a tape recorder capable of recording 14 tracks and surviving 500-g impact deceleration and 1500-g shock. It is for a surface-to-surface missile.

ANSWER TO LAST WEEK'S PROBLEM: Two equations with three unknowns are not necessarily unsolvable, for one of the unknowns. In this case, it's time, which turns out to be 3-7/11 hours.

LITTON INDUSTRIES
Beverly Hills, California

SAC FLEXES A NEW MUSCLE

Beneath the wings of its B-52 intercontinental bombers SAC now packs a formidable new weapon—the GAM-77 HOUND DOG air-to-surface missile. The first operational unit to carry the supersonic HOUND DOG is the 4135th Strategic Wing, based at Eglin Air Force Base, Florida.

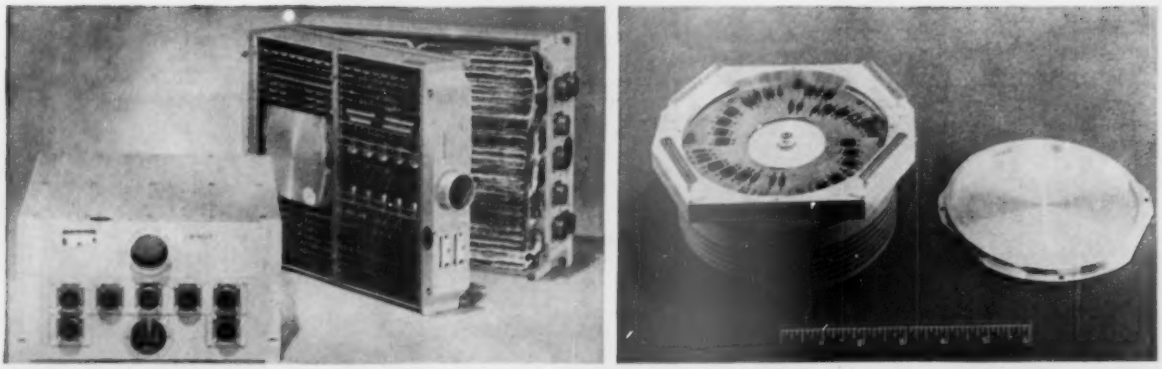
This B-52/GAM-77 union greatly extends the useful life and striking power of SAC's long range bombers and adds to the command's operational flexibility.

The HOUND DOG's versatile capabilities have been demonstrated in a number of free flights over the Atlantic Missile Range and the Eglin Gulf Test Range. In addition, it has withstood many extreme environmental tests including a 10,800 mile flight over the North Pole ending with a successful firing over AMR.

In just 30 months, the HOUND DOG air-to-surface missile progressed from the drawing board to its first flights with SAC crews. Combined with the B-52 bomber, the HOUND DOG gives SAC a powerful new deterrent for preserving world peace.

THE MISSILE DIVISION OF **NORTH AMERICAN AVIATION, INC.**

Downey, California



AIRBORNE DIGITAL COMPUTER for Hound Dog inertial guidance system (left), produced by Autonetics, is operating for as long as 1,000 hr. between failures. Computer contains 16,800 components, equivalent of 54 TV receivers. Magnetic disk memory is shown at right.

Digital Computer Reliability Grows

By Philip J. Klass

Washington—Airborne digital computers now are achieving reliabilities which match or exceed those of less complex avionic equipments, a situation which seemed unlikely when digital computers were first proposed for airborne use less than a decade ago (AW Dec. 29, 1952, p. 27.)

At that time, large ground-based computers seldom operated for more than a few hours before malfunctioning. The prospect of squeezing down the size and weight of such computers by a factor of 100:1, and simultaneously increasing their reliability by at least an order of magnitude, appeared dim to many observers.

Today, however, there are at least a dozen avionics companies that have done just that, and still are slashing away at airborne digital computer size and weight while pushing up reliability.

Hound Dog System

One example reported at the recent San Diego meeting of the American Institute of Electrical Engineers is the digital computer for the inertial guidance system used on the Hound Dog air-to-surface missile, produced by North American's Autonetics Division.

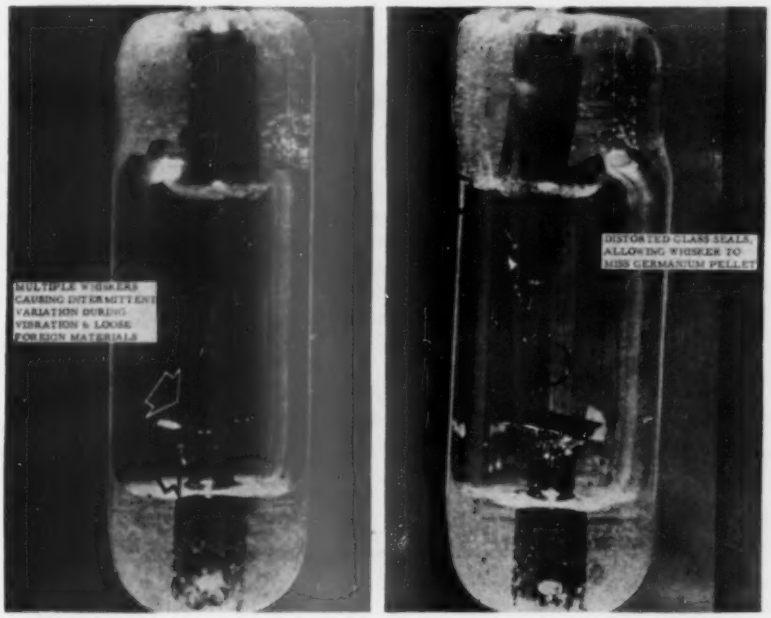
The computer contains approximately 16,800 components, roughly the equivalent of 54 home television receivers in terms of number of components, according to Joseph F. Cherney, Autonetics project engineer. But the computer occupies only 1.4 cu. ft., smaller than one home TV receiver.

Some of these Hound Dog computers have exhibited mean-time-between-failure (MTBF) of close to 1,000 hr. This is roughly the equivalent of a home TV receiver operating for 6 hr. every day for 25 years without a single malfunction.

Autonetics records of Hound Dog computers that came off its line during early production and went into service use show an average MTBF of about 70 hr. Improved quality components introduced early this year are expected to double this MTBF figure for computers now rolling off the line, Cherney indicated.

The Hound Dog computer is essentially two computers in a single package. One is a digital differential analyzer, which performs real-time computation required for missile guidance. The other is a general-purpose machine which performs infrequently-required computations, makes periodic self-tests of overall computer operation and performs diagnostic routines when malfunction occurs.

Computer also contains an input-output section for analog-to-digital and digital-to-analog conversion. Machine is designed to accept 56 independent input channels of five different types and



MICROSCOPIC examination of each diode can disclose mechanical defects which do not show up in diode functional tests but which can cause failure in subsequent service. Two typical defects are shown above.

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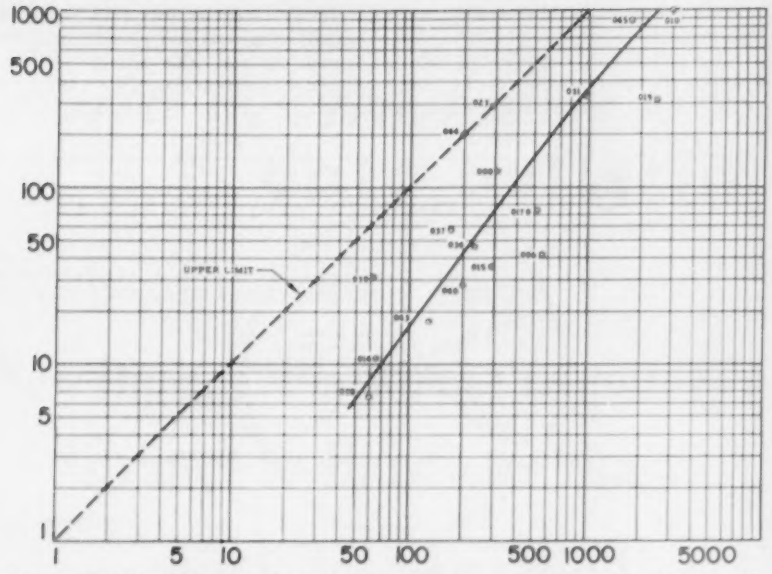


MEAN-TIME-BETWEEN-FAILURE of early Hound Dog computers shows wide variation, with some evidence of "infant mortality" type failures in early use. Numbers alongside each dot show serial number of the computer. Current units are expected to show higher reliability.

38 independent outputs of six different types, Cherney reported.

Computer is contained in a single assembly, measuring 15¼ x 20 x 8 in. It employs a total of 93 plug-in modules, measuring 3 x 8 in., each mounting an average of 180 components on both sides of an etched circuit board. A rotating magnetic disk serves as the computer memory.

During manufacture, each module is subjected to extensive functional testing using automatic test equipment. The completely assembled computer must then operate for five hours, continuously performing computations, before it is released to be incorporated in the guidance system. Here again the computer is tested as a part of the over-all guidance system tests.

Improving Reliability

Because diodes make up roughly half of the total components used in the computer, and transistors constitute another 10%, Autonetics turned its attention to these two devices when it sought to improve original computer reliability. Although Autonetics originally selected semiconductors built to military (MIL) specifications wherever possible, it nevertheless found it necessary to conduct extensive test and inspection of incoming devices to meet its over-all reliability requirements.

Autonetics, one of the first companies to use X-ray and microscopic inspection of vacuum tubes some years ago for its Navaho missile program, also instituted microscopic inspection of its glass-encapsulated diodes. It found a number of mechanical defects in diode fabrication, not detected by the semiconductor turer's plant.. Autonetcis fed back its ode to malfunction under extreme environmental conditions even though the unit could pass functional incoming inspection tests.

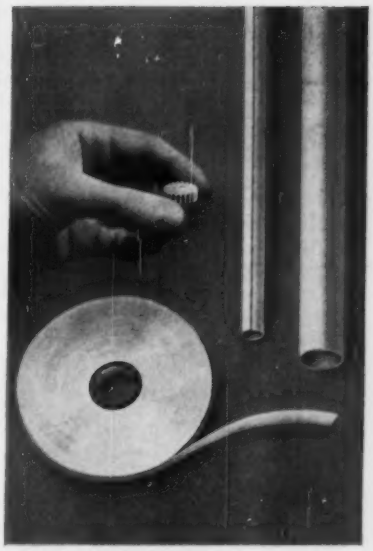
Recognizing that such inspection rightfully belongs to the diode manufacturer's plant, Autonetics fed back its findings to its suppliers and has since gotten them to institute microscopic inspection and other controls intended to improve semiconductor device quality, Cherney told AVIATION WEEK.

The introduction of added quality controls at the component manufacturer's plant can be quite costly in terms of individual component cost. But the more costly components increase the over-all computer cost only slightly and greatly improve its reliability, Autonetics investigations showed.

For example, although Autonetics now is paying approximately three times as much for its diodes as it formerly paid, and correspondingly more for its transistors and connectors, these higher quality components increase over-all computer cost by only 5%, according to Cherney. But they are expected to more than double its mean-time-between-failure figure.

One Hound Dog computer, selected at random from the production line more than a year ago, has been operated in the laboratory for a total of 7,445 hr. with an average MTBF of 620 hr. If it were not for three malfunctions that resulted from careless workmanship in the repair of the computer, the average MTBF would have been more than 1,000 hr.

During the last 735 hr. of the test, computer was cycled on and off nearly



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3,200 times at 15-min. intervals without any component malfunctions, according to Cherney.

Records of failures occurring in early production computers after they have been mated with the rest of the guidance system and subjected to over-all system tests show a considerable spread of MTBF figures, ranging from a low of 7 hr. to as high as 1,000 hr., with a median value of about 70 hr.

Analysis of the results of these tests suggests that digital computers may experience a form of "infant mortality" similar to that of vacuum tubes and other components where failure rate is highest in the first few hours.

Data indicates that computers that had operated for the longest total time had the lowest failure rates, whereas those that had been operated for only short periods of time had comparatively high failure rates. If subsequent data confirms the existence of this infant mortality, it would be logical to operate all computers in the factory for sufficient periods to carry them past the high failure rate interval.

Puerto Rico Radar To Probe Ionosphere

Washington—Radar with a 1,000-ft.-diameter antenna, termed the world's largest, will be built in Puerto Rico to support the work of the newly established Defense Department Ionospheric Research Facility.

Site of the antenna, which will be in the form of a bowl or segment of a sphere, will be in a natural valley formed by several mountain peaks 10 mi. south of Arecibo, which is on the north coast of Puerto Rico, and 29 mi. east of Ramey AFB.

Initial studies will be made of the nature and characteristics of the earth's ionosphere, roughly between 40 and 600 mi. above the earth's surface. The antenna will not only be able to act as a radio telescope of great sensitivity, but will be able to transmit pulses which will be reflected from the ionosphere, the moon, the planets of the solar system and other objects in space.

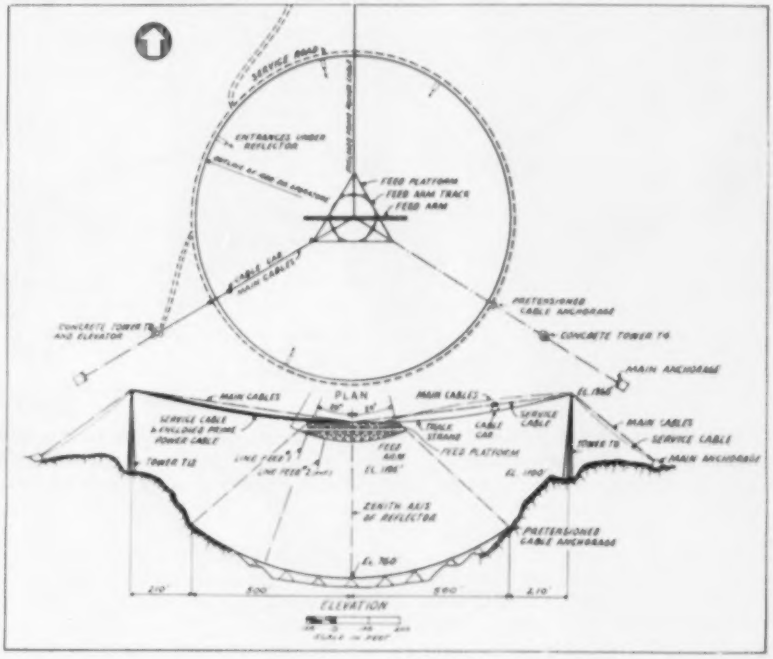
Direction and funding of the $5.5 million project is under the Advanced Research Projects Agency, with technical support and management by the Research Division of the Air Research and Development Command. Prime contractor is Cornell University, which conceived the idea.

Although the segment of a sphere would be aimed at one point in space if a fixed feed and reception system were installed, the actual capability will cover a cone of 40 deg. by moving the feed point.

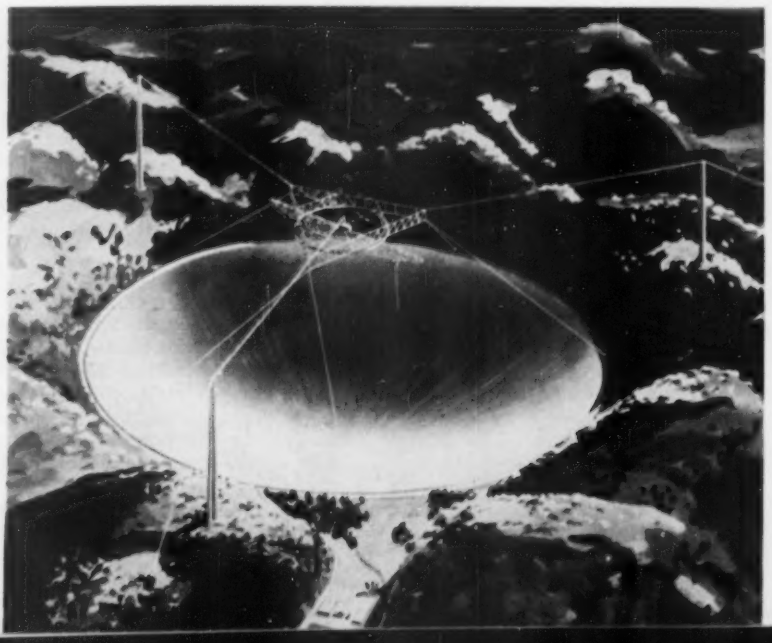
Power of the radar will be greater than any comparable instrumentation now in existence, enabling contact with the planets.

One possible accomplishment will be learning the rotational rate of the planet Venus, whose dense clouds have defied scientific surface analysis in the past.

It also will be useful in detecting signals from stars and planets, solar disturbances, and the source of non-thermal radiation from the planet Jupiter.



WORLD'S LARGEST radar telescope, with antenna dish diameter of 1,000 ft., capable of detecting a 3-ft.-square object 22,000 mi. away, is being constructed in a natural limestone bowl in Puerto Rico. It is expected to be in operation in July, 1961. Operating at a frequency of 400 mc. with peak power of 2½ megawatts, radar will be used to study surface of the moon, sun, Venus and Mars, and to measure the rotation, size and distance of solar system planets and probe the atmosphere of Mercury and Jupiter. Radar will also be used to measure earth's ionosphere electron density, temperature and motion and earth's magnetic field. Facility also can be used as a radio telescope. Antenna scanning will be accomplished by feed mechanism, suspended over fixed antenna dish, which can rotate through 360 deg. in azimuth and swing 20 deg. off vertical. Facility is being built under sponsorship of Advanced Research Projects Agency with Air Force Research Division as responsible agency.



FORD INSTRUMENT CO.
data bulletin

Developments at Ford Instrument Co., Division of Sperry Rand Corporation, that are of particular interest to users of special-purpose computers and controls.

NO. 2 OF A SERIES OF ADVERTISEMENTS — LONG ISLAND CITY 1, N. Y.

New Digital "Platform Computers" Advance to Hardware Stage

Slated to Replace Bulky "Stable Elements" in Aero-Nav Systems

Two new special-purpose digital computers, now being designed and built by Ford Instrument Co. as part of the AN/AJN-7 "strapped-down" inertial navigation system, moved recently from the theoretical to the hardware stage with construction of the first equipment modules.

Developed by Ford Instrument, under U. S. Air Force contract, for the Weapons Guidance Laboratory of Wright Air Development Command, the new "Fordac" computer is the heart of an airborne inertial navigation system that does away with the "stable platform" of conventional inertial navigation systems. The new system is called a "strapped-down" inertial system (or sometimes a "platformless" or "no-gimbal" system) because the gyroscopic components are body-mounted. The usual functions of a stable platform are performed by the computer mathematically.

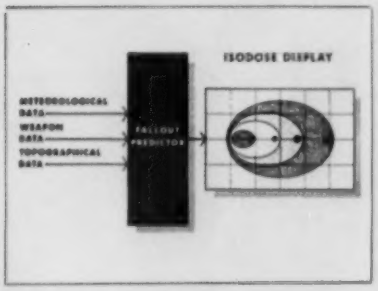
In its final configuration "Fordac" will be a compact, lightweight, all-solid-state computer especially suited for airborne packaging. It employs novel techniques to compute and maintain the nine direction cosines that relate the coordinate system defining the vehicle axes to a space-fixed frame of reference. The name "Fordac" is derived from the words "Ford Altitude Computer."

In conventional inertial navigation systems, the moving gimbal structure requires a great deal of unobstructed space. Usually, space requirements increase with accuracy requirements. Furthermore, gimbal structures must be built to expensively close tolerances. All of these problems are bypassed in the AN/AJN-7 system.

The second computer, which was developed by Ford Instrument under a supplement to the original AN/AJN-7 contract, is a new solid state digital computer that combines incremental and DDA (Digital Differential Analysis) techniques. The computer has been nicknamed "Poco" from "POsition COmputer." It will combine the output of "Fordac" with information from vehicle sensors to compute the position of the vehicle with respect to the earth.

Ford Instrument Co. engineer tests one of first equipment modules for prototype "Fordac" digital computer.

New Fallout Predictor to Aid National Defense



New Ford Instrument fallout predictor can automatically present data in form of contour map, such as shown at right. Shaded areas indicate points of equal radiation dosage.

A new computer to predict nuclear fallout patterns from complex nuclear-weapon, topographical, and meteorological data is being developed at Ford Instrument under U. S. Army Signal Corps contract from Ft. Monmouth, N. J.

The equipment automatically delivers its solution for instantaneous decisions, and will cover an area up to 3-million square miles.

The contract for the new computer extends the pioneering work previously done by Ford Instrument on the subject of determining radiation effects. The work encompassed all of the problem areas from theoretical meteorology through error dynamics.

The new fallout predictor will evaluate the numerous parameters, and their relationship to anticipated fallout distribution, with regard to time and space under varying meteorological conditions. Fallout predictions are considered from the viewpoint of having a minimum amount of meteorological data available.

The new fallout predictor represents just one example of Ford Instrument's special-purpose computer capabilities which extend to every phase of computer development, from design to quantity production.

Left: Ford Instrument technicians assemble and test stable platforms for Army JUPITER missile in part of Ford Instrument's extensive "clean-room" facilities.

Right: U. S. Army JUNO II, carrying the PIONEER IV space probe and many Ford Instrument guidance and control components, is launched toward moon by National Aeronautics and Space Administration. *U. S. Army photo*

Eleven Years of Missile Guidance

1960 marks the 11th year since Ford Instrument received its first contracts for missile guidance or control. These first contracts were for the prototypes of the launching and control-order computers for the still-operational U. S. Navy TERRIER missile.

With these contracts, Ford Instrument began to apply to space-age weapons the experience gained in 34 years of conventional weapons-control-system work. And since these contracts, Ford Instrument has accumulated an impressive array of experience as a designer and manufacturer of guidance systems, subsystems, and components for some of this country's most modern and effective guided missiles.

Notable among these are: The complete inertial guidance and control systems for the Army REDSTONE and JUPITER missiles; many such guidance and control components for the satellite-launching JUPITER C; control components for the "man-in-space" vehicle, MERCURY; launching and control-order computers for the Navy's TARTAR missile (in addition to those for the TERRIER, mentioned above); Air Force missile projects, including the "strapped-down" or "platformless" inertial system described in another story in these pages—plus a wide variety of ground-support and production test equipment for missiles.

The outstanding reliability and extreme accuracy of the REDSTONE and JUPITER missiles—as well as the record of the JUPITER C—demonstrate Ford Instrument's capabilities in the area of guidance and control. Ford Instrument was the first company in the country to set up production lines for extremely accurate air bearing components—gyroscopes and accelerometers—used in these missiles.

Warhead Capabilities

Ford Instrument's capabilities in missile systems also include wide experience in warhead instrumentation. Ford Instrument has recently received a $2.3-million contract from Bulova Research & Development Laboratories, Inc., to develop and produce, under technical direction of Picatinny Arsenal, a fuzing device for the Army's newest missile, the PERSHING.

Notable completed activities in this field include: safety, fuzing and arming devices for atomic weapons, and the fuzing device for the JUPITER missile. Unlike many present-day fuzing devices, these Ford Instrument devices require no electric power and are totally interference-proof.

Today, Ford Instrument has the experience, facilities, and capabilities to enable it to undertake complex missile contracts on every level—from component or subsystem to complete weapons system. Ford Instrument has earned the reputation of being able to handle the toughest jobs in missile development and manufacture.

Remington Rand to Use New Reversible Data Converter

Remington Rand Company, Division of Sperry Rand, has ordered a new version of Ford Instrument's multi-channel, all-solid-state, reversible analog-to-digital converter for use in future USN shipboard systems. The use of such converters makes possible the application of the latest digital techniques on ships where analog sensing devices are employed.

Considered the most versatile data converter available, this equipment was originally developed by Ford Instrument under contract with the U. S. Navy Bureau of Ships. The first unit recently completed successful evaluation tests at the Naval Electronics Laboratory, San Diego, Calif.

Referred to as a "reversible universal sensor data converter," this device can be made to accommodate either analog-to-digital or digital-to-analog flow of information for all types of voltages. Although developed for a specific project, modifications can readily adapt it for use with almost any digital computer. The fact that it can translate digital output information into analog terms—as well as the reverse—makes the new converter ideal for actuating analog-type servo and control systems for applications such as aircraft flight control, missile launching and guidance, and industrial control systems.

Separate converters have been required in the past for each type of analog input voltage delivered by the various types of sensors. Now, for the first time, a single solid-state converter is capable of handling widely different types of voltage inputs. In the new converter, analog inputs in the form of a-c voltages, d-c voltages, and synchro signals can be converted at the rate of 4000 samples per second. Studies indicate that the equipment can be packaged into less than one-half cubic foot, making it ideal for airborne and missile applications.

The new digital converter is the outgrowth of six years of development work in this field. It was designed and fabricated to military requirements and specifications.

New Precision Computer Components

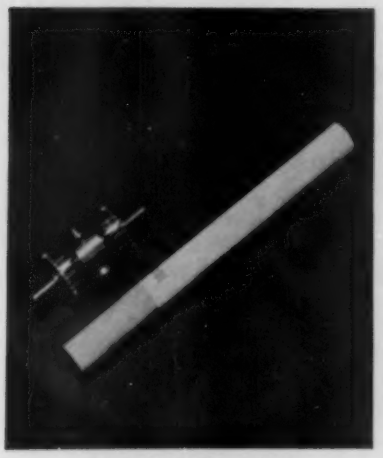
A new 1/2-inch ball-disc integrator and a new 3/32-inch standard differential are among the latest units added to the Ford Instrument line of on-the-shelf precision mechanical and electromechanical computer components.

The new 1/2-inch integrator achieves the same accuracy as previous integrators with discs three times as large and represents a major "breakthrough" in the design of mechanical integrators.

The 3/32-inch differential is the smallest of Ford Instrument's single spider-gear differentials. This unit provides extreme accuracy in additive and subtractive operations with minimum friction and backlash.

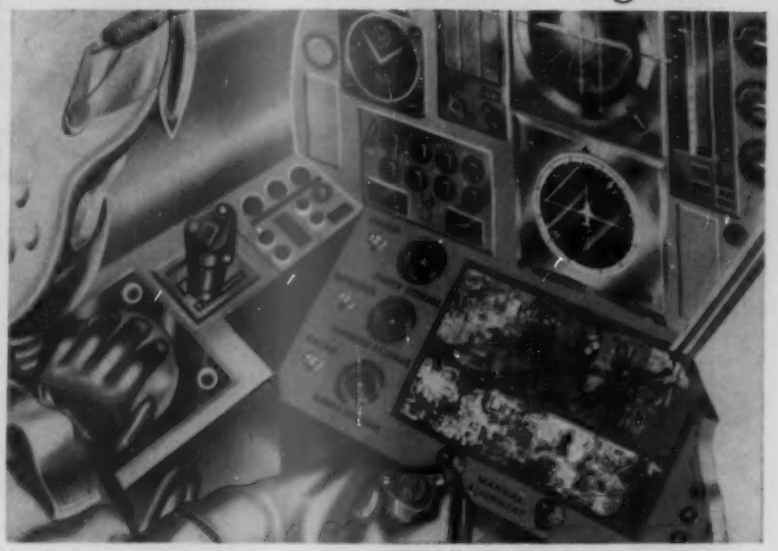
Product data sheets on these units—as well as on Ford Instrument's Telysyn® synchros and other electromechanical components—are available for the asking. Write Components Division at address on back page.

New 1/2" integrator.



New 3/32" differential.

Aerial Recon Data Integrated



One possible method of combined sensor display presentation. Pilot would be enabled to act at once on in-flight data, instead of returning to base for analysis of data.

Study Seeks Optimum Display Methods for Radar, Infrared, and Photo Data

Here's one artist's conception of the type of combined sensor display information our reconnaissance pilots may be looking at shortly in the future.

It represents a possible result of a new all-weather, multi-sensor display study being undertaken at Ford Instrument under an Air Force contract from Wright Air Development Division.

The project will develop optimum methods for airborne interpretation of information received from the most commonly used types of reconnaissance sensors — photographic, radar, and infrared—immediately after exposure.

Viewing rates, illumination levels, display scales, and many other parameters of reconnaissance viewing are being evaluated, and particular emphasis is being placed upon the correlation of information from more than one sensor type.

The new study contract, one of the largest ever received by Ford Instrument in this field, extends the pioneering work of the company on the subject of Integrated Sensor Interpretation Techniques. A wide array of specialists, including image interpreters, human engineering specialists, and engineers, are applying their special talents to these problems.

Radar, infrared, and aerial photography, when used independently, each have advantages and limitations; but, in combination, they make possible more effective and reliable in-flight target detection.

Radar, operating at any time of day or night and in all but the worst weather, is especially useful for detecting metallic objects and structures.

Infrared images are clear where there are temperature differences between the objects or features recorded. Therefore, targets which are warmer than their surroundings are detectable by infrared even while they are not visible on the aerial photograph.

Since both radar and infrared possess desirable properties which high resolution aerial cameras do not have, it is possible to make use of a combination of these sensors for more reliable in-flight target detection. The present work is primarily directed toward certain military missions, but it is possible to extend it toward other types of aerospace missions.

Simulated presentation, at Ford Instrument, allows study of combined sensor displays by psychologists and human engineers as well as equipment engineers.

Recon Drone Unit Delivered

The prototype model of the AN/UPW-1 drone control, built by Ford Instrument for the U. S. Army Signal Corps, was shipped to Fort Huachuca, Ariz., recently for a rigorous series of field tests.

The system, shown here during final New York checkout before shipment, comprises an optical acquisition unit (extreme left), a portable control unit (in front of map), and a trailer mounting a map plotting board, computer and radar. Designed for battlefield use, the equipment can be set up, camouflaged and put into operation by two men in an extremely short period of time.

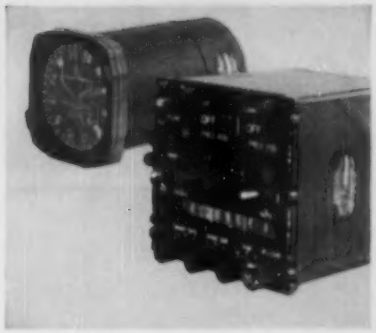
Engineers, Scientists Needed

New programs at Ford Instrument have created outstanding employment opportunities for experienced systems engineers and scientists for work in digital computer engineering and programming, advanced mathematics, thermionics, experimental solid-state physics, and microwave devices. Address inquiries to A. L. Buckwalter. They will be held in strict confidence.

Computer Navigation Scores Again

The U. S. Air Force has recently awarded Ford Instrument Company an additional $6 million, approximately, in contracts for AN/ASN-7 navigation systems, components, and test equipment.

During the previous nine months, U. S. Air Force contracts for this equipment have soared to approximately $11 million. The



AN/ASN-7 is a dead-reckoning course and distance computer system being used in KC135's, F101-F's and other aircraft to provide extremely accurate navigation.

Thermionic-Cell Temperatures Lowered

Ford Instrument research in thermionics has lowered operating temperatures for experimental tungsten-cesium cells to about 2,200°F, as against 4,000°F previously required, for substantial current densities.

This is one of the latest results of Ford Instrument studies in thermionics—the direct conversion of heat to electricity. As

Ford Instrument engineer applies heat from torch to experimental thermionic cell.

power supplies, the new thermionic cells are expected to have the advantages of light weight, compactness, complete lack of moving parts, complete silence—important for military use—and the possibility of utilizing the heat (as well as the electric) output of the cell.

Additional Ford Instrument activities in the new field of thermionics include: construction of experimental thermionic cells; investigation of the feasibility of building thermionic converters into the fuel elements of nuclear reactors; the use of fossil fuels and solar energy for thermionic conversion; and studies of numerous possible applications of thermionic power.

Thermionic power sources are expected to have wide potentialities in a variety of practical applications, such as supplying power for sonobuoys, survival equipment, space satellites or vehicles, or any equipment where light weight and compactness are essential.

We invite you to learn more . . .

Responsible agencies or industries, possessing the requisite security clearance and need to know, are invited to learn more about Ford Instrument capabilities. Ford Instrument Liaison Engineers are always ready to discuss your new or special requirements, and will be glad to provide you with detailed information on specific project capabilities.

FORD INSTRUMENT CO.
DIVISION OF SPERRY RAND CORPORATION

31-10 Thomson Avenue, Long Island City 1, New York

Field Liaison Engineering Offices

DAYTON, OHIO
Ford Instrument Co.
Suite 1310, Talbott Tower
Dayton 2, Ohio

HUNTSVILLE, ALA.
Ford Instrument Co.
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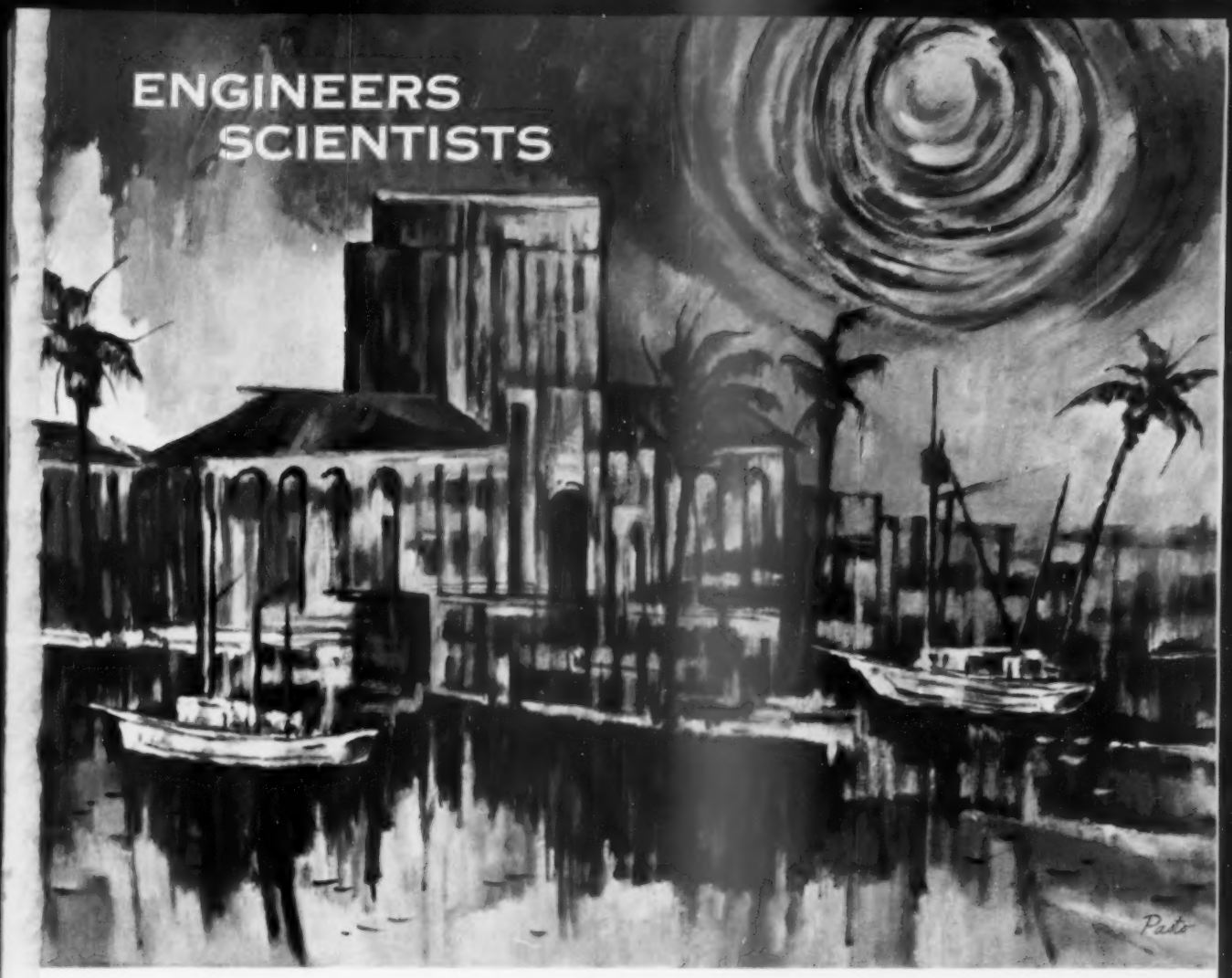

San Diego Civic Center, an original painting by Sammy Pasto, Convair/San Diego artist

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This information will enable the professional staff at Convair/San Diego to make a preliminary evaluation of your background. A personal interview can be arranged in your city by appointment. Every completed inquiry will be acknowledged.

PERSONAL INFORMATION

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ame_____

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DUCATION: College Graduate: Yes ☐ No ☐

egree: BS ☐ MS ☐ PhD ☐

AJOR SUBJECT: Physics ☐ Mathematics ☐

ectronic Engineering ☐ Mechanical Engineering ☐

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PERIENCE: Primary Specialty_____

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Specialists for the analysis and development of automatic controls.

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For analysis of problems associated with rarified gas dynamics (free molecular and continuum flow), ablative heat transfer and hypersonic boundary layer injection processes. Advanced degree and three to five years of experience preferred.

FLUID MECHANICS

For statistical mechanics and information theory. A PhD, or equivalent, is required.

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For aerodynamic design problems of subsonic and supersonic jet transports, advanced space vehicle programs, VTOL and STOL aircraft, and advanced missile systems.

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A number of select positions, encompassing a broad spectrum of activity in the physical sciences, are available for PhD physicists. Current experimental and theoretical studies involve plasma, solid state, molecular, nuclear, and optical physics. Experimental physicists are also required for work in light wave reflectivity, observing experimental phenomena. Work includes some build-up and modification of laboratory equipment, including monochrometers.

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Experienced in fractional distillation of cryogenic fluid and ortho-para conversion of hydrogen. MS in chemical or mechanical engineering preferred.

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Analytical and computer gaming of operation of commercial and military systems. Involves preliminary system design through economic effectiveness studies.

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Reliability engineers with statistical background for systems analysis. Experience in aircraft or missile system reliability required.

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INFRA-RED

Specialists with experimental background and experience in IR detection devices for IR instrumentation, spectral analysis, and radiation studies.

COMPUTER PROGRAMMING

Programmers with a minimum of one year experience on IBM 704 computers. A BS degree is preferred.

•

For additional information concerning these, or other attractive positions, mail the Professional Employment Inquiry on the left. If it has been removed, or if you desire to furnish us with more detailed information, write to Mr. M. C. Curtis, Industrial Relations Administrator-Engineering.

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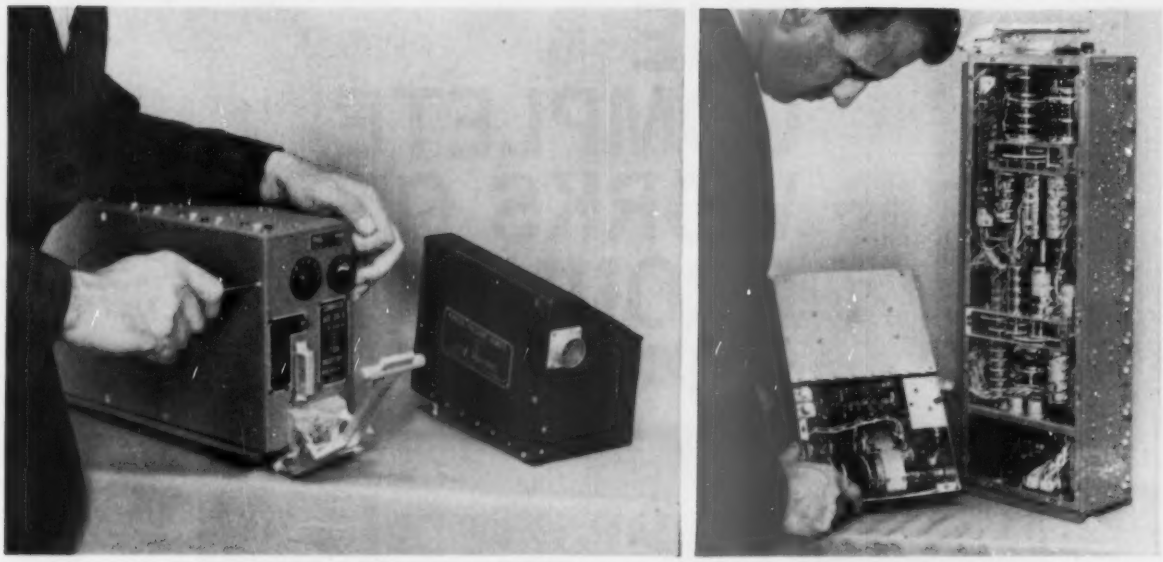


CENTRAL AIR DATA computer system developed by Electronic Equipments Div. of Litton Industries in Beverly Hills, Calif., employs specially-designed unbonded strain gage transducers for extreme stability and repeatability. Computer (left) weighs 21.7 lb., occupies 750 cu. in., while remotely located transducer-servo package (to right of computer) weighs 6.1 lb., takes up 190 cu. in. At right, panels are removed from both packages, revealing layout of gears, potentiometers and other components.

Litton Develops Fighter Air Data Systems

By Barry Miller

Beverly Hills, Calif.—Lightweight, central air data computer systems capable of providing navigation and engine, fire and flight control information for supersonic fighters over flight profiles from sea level to 80,000 ft. and from speeds of Mach 0.2 to 2.5 are being developed here at Litton Industries, Inc.

According to the company, system prototypes made by its Electronic Equipments Division now are undergoing evaluation. Quantities of these air data systems recently were ordered for an advanced supersonic fighter program. The air data systems can provide outputs for such functions as:

- **True airspeed** accurate to within 10 kt.
- **Altitudes** within 284 ft. at 80,000 ft.
- **Mach number** within 0.01 m.
- **Angle of attack** within 0.1 deg.
- **Density ratio** within 0.0038.
- **Differential pressure** within 0.16 in. of mercury.
- **Total pressure** within 0.062 in. of mercury.

Pressure Transducers

The system employs specially developed unbonded strain gage pressure transducers which experience little environmental impairment, provide high accuracies, occupy little space and add negligible weight. These transducers were developed and are supplied by Statham Instruments, Inc., of Los Angeles and are largely responsible for the principal advantages of the system, cited by Litton as:

- **Instantaneous response** of the transducer to dynamic pressure changes.
- **Location of small,** lightweight, pressure transducers 1⅛ in. long, ⅜ in. diameter, ½ oz. weight (near sensing ports in one of two versions of the system), thus eliminating pneumatic line delays.
- **Insensitivity** of the transducer to aircraft orientation, temperature, acceleration, vibration or shock.
- **Accuracy on the order** of 0.1% full scale of the transducers and associated computing equipment over pressure ratios as high as 145 to 1 (110,000 ft. to sea level).

System Packaging

Entire system can be packaged in a single integrated unit which weighs about 22 lb. or in two separate pieces—computer and a remotely located transducer-servo package which weigh 21.2 and 6.1 lb., respectively. The transducer-servo package occupies about 190 cubic in., the computer about 750 cubic in.

The strain gage pressure transducer which has no moving parts was designed specifically for this Litton computer application although commercial versions are not now available, according to a spokesman for Statham. Qualification tests on the transducers show their ability to withstand 75g shock (with only 0.072% change in output) and 75g acceleration, Litton says.

A self-contained pressure-to-analog converter, the strain gage does not need complex associated equipment, Litton points out, and thus enhances reliability, shrinks size and weight of the sensor package and allows freedom in mechanical layout. Its small size permits quick thermal stabilization provided by transistorized temperature control and once stabilized, Litton adds, the transducer is insensitive to dynamic or steady-state environmental temperature changes.

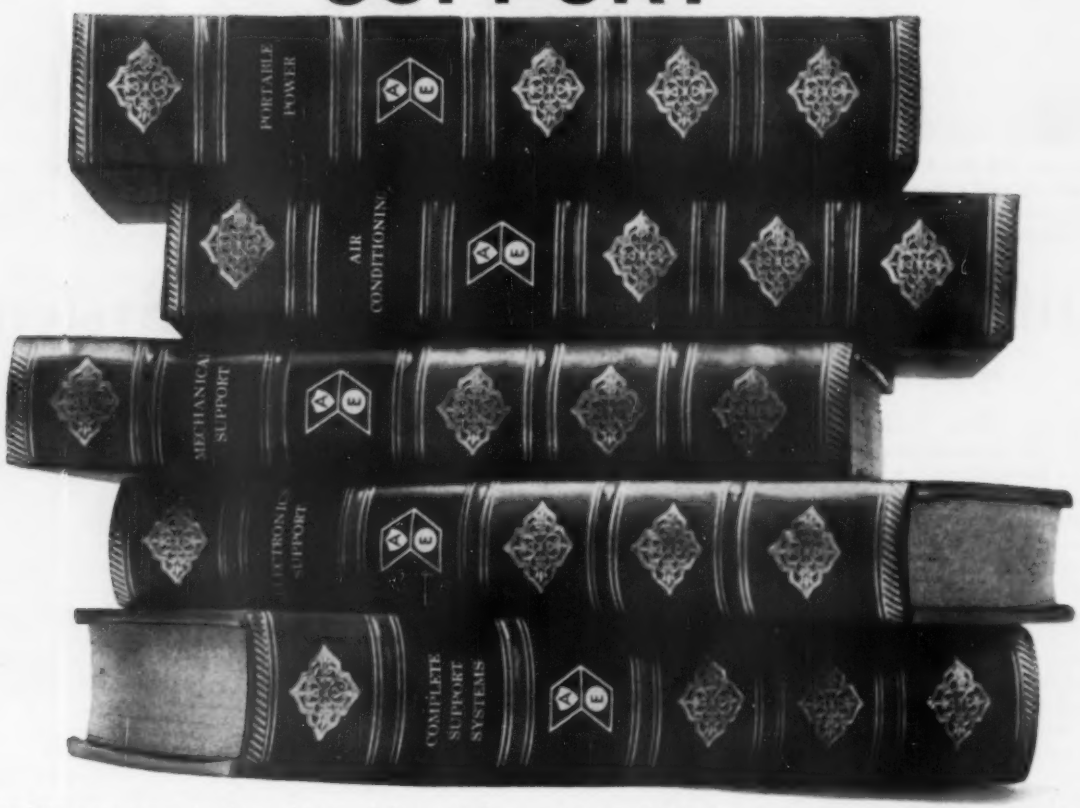
Gage Performance

The gage is a continuous resistance wire element in the form of a bridge circuit the resistance of whose arms varies under mechanical stress to produce variations in output voltage. The transducer senses static and total pressures and converts these into voltage analogs. While gage operation is continuous and output resolution effectively infinite, over-all resolution is fixed by other elements in the system. Individual units have low hysteresis—about 0.03% in worst cases—and low linearity error over extreme pressure excursions.

Litton regards the pressure transducer, which it says holds accuracy and stability after exhaustive pressure cycling, as the most reliable element in the computer.

Mechanically, the computer is designed for simplicity and ease of mainte-

THE COMPLETE WORKS ON GROUND SUPPORT



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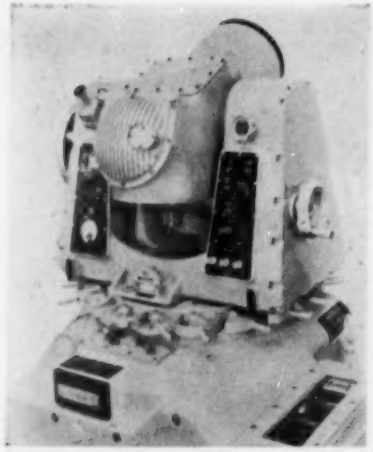

Electro-Collimator

Electro-collimator, built by Perkin-Elmer Corp., consists of modified optical theodolite plus associated electronic sensing and control circuits built into trunnions that support optics.

nance. Gear train modules including clutch assemblies, pots, and servo motors are designed for easy replacement and service, according to Litton. Quick release type clamps secure electromechanical components to mounting surfaces and servo amplifiers and power supply components are mounted on plug-in circuit cards. The transducer assembly is contained in a separate module for removal without disturbing other components.

Output Functions

Output functions proportional to altitude, density, total pressure, true airspeed, Mach number and differential pressure are derived in the system from analog computations on static pressure, total pressure and total temperature. True angle of attack is derived from corrections as a function of Mach number in a true angle of attack servo and the input from an angle of attack vane.

Designed into the system is a biasing circuit for checking the entire system, including transducers on a go-no-go level for one-flight condition. Depression of a button on the front panel of the air data computer causes unbalance in both the static and differential pressure transducer bridge circuits and substitutes a known resistance for the temperature probe resistance element. All servos and output function shafts are then actuated.

An output potentiometer on each shaft can be switched to a meter indicator for visual observation of servo actuation. In another built-in test a precision test relay removes pressure and temperature probe transducers from respective servo channels. Precise voltages corresponding to the selected flight con-

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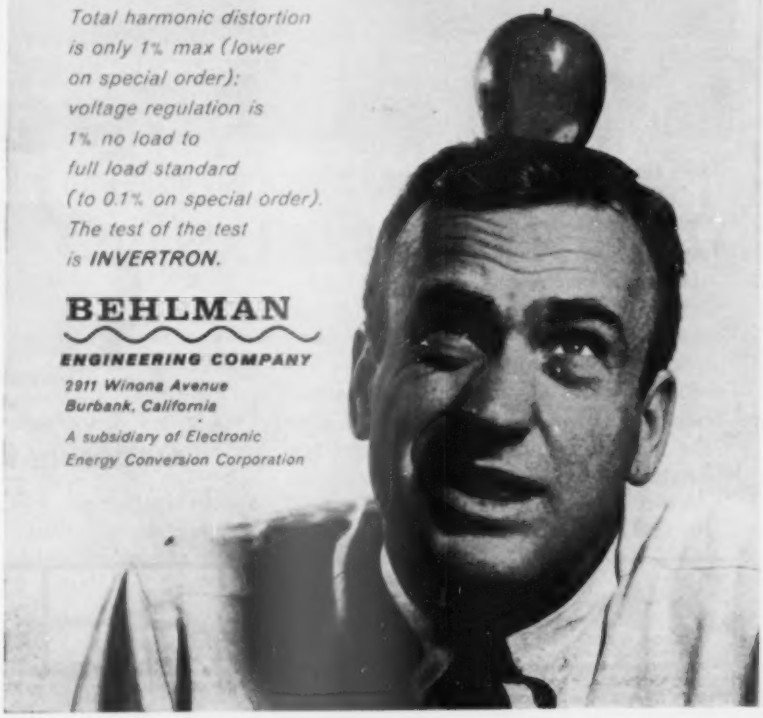

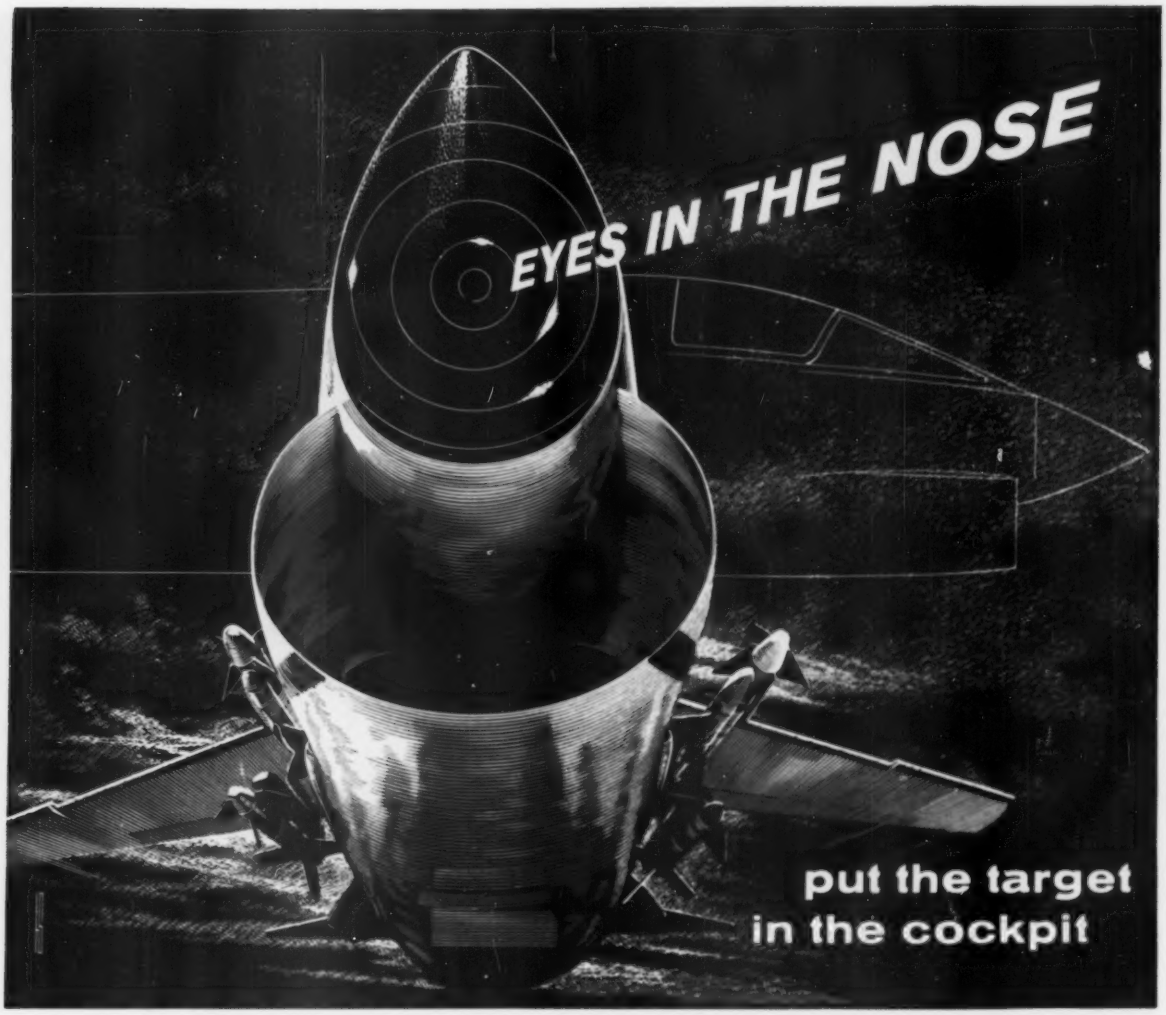

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This airborne radar system is just one of many systems which have been and are being designed and produced to satisfy the tactical requirements of the military services in the fields of Communications, Airborne Radar, ASW, Navigation, Fusing and Data Handling.

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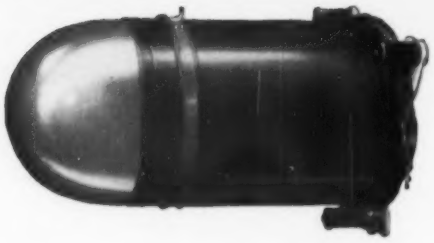

AIRBORNE FIRE CONTROL RADAR

COMMUNICATIONS	RADAR	DATA HANDLING	ASW	MISSILES

THE MAGNAVOX CO. • DEPT. 300 • *Government and Industrial Division* **• FORT WAYNE, IND.**

ditions, the company explains, are then introduced in place of transducer inputs. Selected output functions are available at a top connector and can be monitored by an external checking device.

Development of the central air data computer is the culmination of three years of work for the electronic systems division, which was acquired by Litton from General Controls in December of last year.

FILTER CENTER

▶ **West Coast Share Grows**—Electronic companies in the nation's 11 western states are expected to produce 22% of nation's total output, compared to last year's 20%, according to Western Electronic Manufacturers Association (WEMA). Approximately half of the projected $2.3 billion in sales by western firms will come from companies in the Los Angeles and adjoining Orange County area, but sales by firms in the San Francisco Bay area are growing at a slightly faster rate, WEMA says.

▶ **Speedy Digital Computer**—Airborne digital computer, capable of performing 166,000 mathematical operations per second, is called "fastest military computer available" by Westinghouse Electric's Air Division which developed

Thermionic Converter

Thermionic converter, available in pilot production quantities in October from General Electric, is close-spaced type with output of about one watt when operated at cathode temperature of 1,100C. Device has minimum power density of 0.2 watts/sq. cm. and thermal efficiency of 2½%. GE hopes to add new vapor thermionic converter, using cesium vapor, to its line soon. Company reports vapor converters with outputs of 2 watts/sq. cm. and efficiencies of up to 12% at operating temperature of 1,300C. Converters are produced by GE's Power Tube Department, Schenectady, N. Y.

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he's a DELAVAN FUEL INJECTOR SPECIALIST

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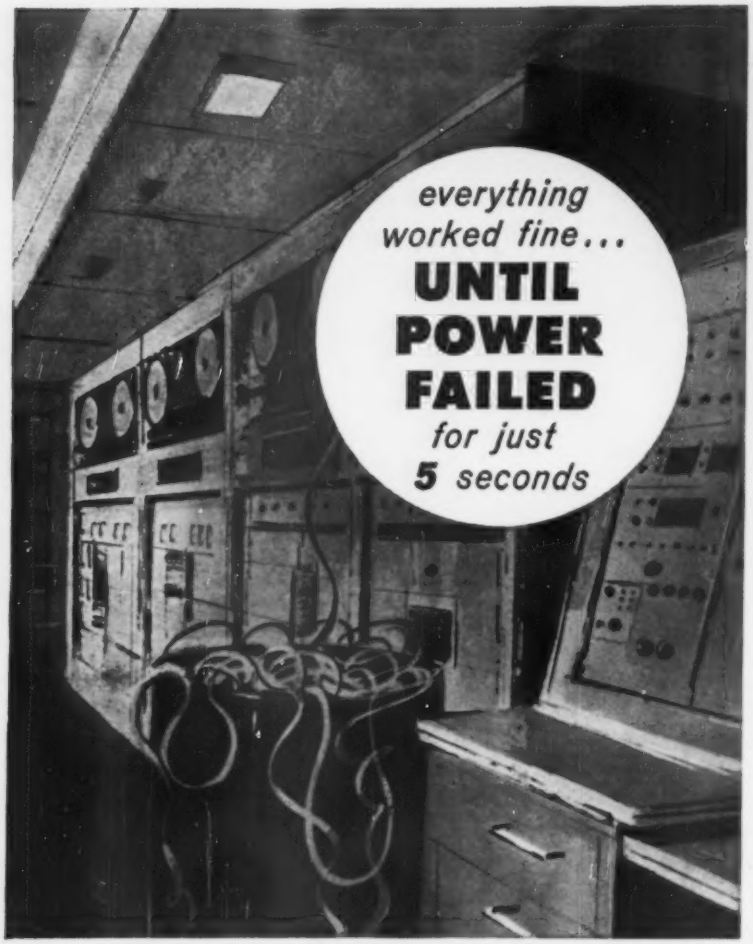

"The telemetering link was working fine. The whine of the tape as it passed over the recording heads was a precise information-laden sound. Then . . . we had a power failure. Five seconds later we were back in business, but at the cost of millions of bits of information . . ."

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These diesel-driven units are available in sizes ranging from 10 to 200 kilowatts. Since the engine runs only when emergency power is required, operating costs are negligible, maintenance, practically nil. **Can you afford to be without an UPS unit?** A phone call, wire or letter will arrange a demonstration at our plant.

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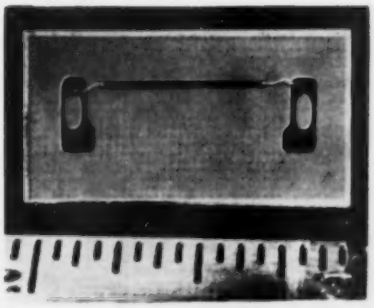
Strain Gage Transducer

Semiconductor strain gage transducer, available in pressure range of 0-100 psig. to 0-10,000 psig. full scale, includes both semiconductor strain gage pick-off and a built-in transistorized amplifier. Input excitation is from 10 to 25 vdc., with output at full scale equal to one-fourth input voltage. Input impedance is 700 ohms, output impedance is less than 4,500 ohms. Transducer, designated the 3S-G, is 1¼ in. in diameter by 3 in. long and weighs 5 oz. Linearity is quoted at 0.1% and operating temperature range is −65F to 250F. Manufacturer: Fairchild Controls Corp., 225 Park Ave., Hicksville, L. I., N. Y.

the machine. Computer occupies 6½ cu. ft. and is fully transistorized with silicon devices. Magnetic cores are used for storage, with capacity for 50,000 bits. Computer has completed 800 hours of testing, company reports.

▶**New Microwave Use for Garnets**—An L-band circulator using polycrystalline hybrid garnet, which exhibits insertion loss of less than 0.2 db., has been developed by Sperry Microwave Electronics Co. under Rome Air Development Center sponsorship. Company reports that garnet isolator showed no evidence of deterioration at peak power levels greater than 40 megawatts and average power levels of 50 kw. Sperry has designed garnet isolators for operation at UHF frequencies which can handle peak power dissipations of up to two megawatts, company reports.

▶**Growing Oscillators From Vapor**—Relaxation oscillator consisting of a stack of nine layers of varying resistivity and type silicon on a single substrate recently was grown by vapor phase deposition at Merck, Sharp and Dohme in Rahway, N. J. The oscillator is composed of a pnpn switch, back-biased diode and photo detector all deposited and measured individually. Linear growth rate in the vapor phase process is 320 microns/hr.; resistivity can be



Sensitive Strain Gage

Bondable semiconductor strain gage, which employs silicon element that gives gage factor of 130, providing 50-60 times the sensitivity of conventional strain gage, is now available in production quantities. The Model MS-105-350 Micro-Sensor can operate at strains of more than 3,000 micro-inches per inch. Device has resistance of 350 ohms, operates over temperature range of −65F to 180F. Manufacturer: Micro-Systems, Inc., 2925 East Foothill Blvd., Pasadena, Calif., subsidiary of Electro-Optical Systems, Inc., which developed device. (AW Feb. 1, p. 74.)

controlled to within 10% in the 0.01 to 10 ohm-cm. range, within 50% for the 10 to 100 ohm-cm. range. Doping is controlled within 10%, J. Allegretti told engineers at the recent Wescon show.

▶ **Infrared Scanning System**—Avco Crosley is trying to interest military agencies in its high resolution, all solid-state IR (3½ to 5 microns) scanning system. System employs liquid nitrogen cooled indium antimonide detector. Power is 400 watts/steradian at 20 mi.; field of view is 40 x 60. Displayed at recent Wescon show, system had 5-in. display but smaller 3-in. display could be substituted for military applications.

▶ **Reliable Computers from Unreliable Components**—Feasibility of building reliable computers from large complexes of essentially unreliable components in parallel, much as the brain functions reliably with its large redundant system of unreliable neurons, is being studied by Eugene Prange of the Air Force Cambridge Research Laboratories and a group at Massachusetts Institute of Technology. Prange is directing his efforts at substituting a net of neurons performing one function for a single formal neuron computing the same function.

▶ **Western Electric Co.** has a $1 million Advanced Research Projects Agency contract for submarine cable systems linking Kwajalein and Roi-Namur in the Marshall Islands, the first contract to be awarded for Project Press. It involves detection and identification of ballistic missile warheads.

Ryan Doppler Navigators for Navy P3V-1

Ryan AN/APN-122 Doppler navigation sets will be installed in the Navy's Lockheed P3V-1 anti-submarine warfare aircraft by Ryan Electronics Division of Ryan Aeronautical Co., San Diego, Calif. Precision gyroscopes (above) are part of system which ties in the Ryan navigators with inertial guidance system built by Litton Industries' Electronic Equipments Div. of Beverly Hills, Calif.

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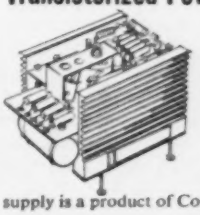

. . . has a unique heat-sink construction. Models available from 2-300 VDC, regulated within ±0.1%, at ratings up to 30 watts. This low-cost plug-in supply is a product of Consolidated Avionics.

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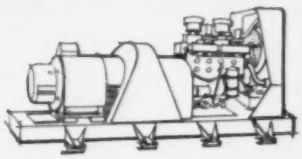

. . . guarantees power without interruption. When prime source fails, UPS automatically takes the full load with no outage whatsoever. Restores full voltage in 1.5 *milli*seconds. Maintains frequency within ±3.5% during transition, ±1% during operation. From 10 to 200KW. Developed and produced by Consolidated Diesel's Power Equipment Division.

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• **Fixed coaxial attenuator,** Series 180, available with attenuations of 3, 6, and 10 db. in the 1 to 12.4 kmc. frequency range, or 20 db. in range of 2 to 12.4 kmc. Temperature coefficient is 0.00043

/db./deg.F. Attenuator measures 7¾ in. long and has 50-ohm impedance. Manufacturer: FXR, Inc., 25-26 50th Street, Woodside 77, N. Y.

• **Miniature magnetic clutch,** Model 162, high efficiency type with minimum torque rating of 10 oz.-in. at speeds up to 1,000 rpm., is available for four operating voltages: 6, 12, 28 and 90 v. The clutch occupies about 1 cu. in., consumes 2½ watts power. Unit operates up to temperature of 85C. Manufacturer: Ultronix, Inc., 111 East 20th Ave., San Mateo, Calif.

• **Miniature coaxial isolators,** requiring no external permanent magnets, are available for operation from UHF to X-band frequencies. Three basic units, designed for use at "C," "S" and "L" bands (Models D44C7, D44S7 and D44L7) operate over 10% bandwidths,

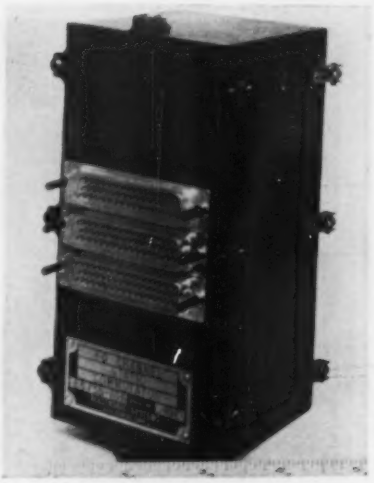
provide more than 15 db. isolation and less than 0.9 db. insertion loss, according to manufacturer. The isolators measure only ¾ in. in diameter with lengths ranging from 4½ in. for C-band to 6⅝ in. for L-band, and weights ranging from 4 to 6 oz. Manufacturer: Sperry Microwave Electronics Co., Clearwater, Fla.

• **Miniature telemetry bandpass filters,** called Minifilters, are designed for transistor applications and printed-circuit board mounting. Type MNF are down less than 3 db. at frequency 7½% off center frequency, while Type MWF are down less than 3 db. at frequency 15% off center frequency. Attenuation greater than 40 db. is provided in the stop bands. Filters are available in 18 different center frequencies, from 0.4 kc. to 70 kc., with complete set weighing only 14 oz. and occupying only 9½ cu. in. Manufacturer: United Transformer Corp., 150 Varick St., New York 13, N. Y.

• **Chopper amplifier,** Model 1801-0100, for converting low-level d.c. signal to higher-power 400 cps. signal, is linear for input of 0-1 v.d.c. but can be operated up to 30 v.d.c. Output voltage is 600 mv rms into a 10,000-ohm load. Unit measures approximately 1¼ x 1¾ x 4 in. and weighs 6 oz. Operating temperature range is −55C to 71C. Manufacturer: M. Ten Bosch, Inc., 80 Wheeler Ave., Pleasantville, N. Y.

• **Magnetic tape recorder,** with frequency response from 50 to 200,000 cps. at tape speed of 60 in./sec., employs all solid-state circuitry. New Pi recorder/reproducer is available in reel-to-reel or continuous-loop models, with head spacing and track width conforming to IRIG standards in 2, 4, 7 and 14 track configurations. Specifications are available from manufacturer: Precision Instrument Co., San Carlos, Calif.

• **Miniature high-pressure transducer,** capable of measuring pressures up to 15,000 psi., weighs less than 0.25 lb. and measures only 1 in. in diameter by approximately 3⅝ in. long. New Series 8416 transducers are available to measure pressure ranges from 0-400 to 0-15,000 psi., gage, absolute or differential pressure. For special applications, transducers can be designed to withstand temperatures up to 600F and vibration up to 35 g and operate in corrosive atmospheres. Transducer is linear to within 1½% over entire range, according to manufacturer. Colvin Laboratories, Inc., 364 Glenwood Ave., East Orange, N. J.



• **Solid-state commutator,** Series ES/35, for time-multiplexing is available in standard scan rates of up to 25,000 cps. and in models accommodating from 2 to 100 channels. Input signal range is 0-10 mv. or 0-5 v., with crosstalk of 0.1% of input signal. Commutator is linear to within 0.1% and has maximum contact resistance of 25 ohms. Manufacturer: Electronic Systems Development Corp., 1484 East Main St., Ventura, Calif.

• **Variable temperature coefficient resistors,** wire-wound type, with temperature coefficient that can be changed from 10 to 4,500 parts per million per degree centigrade by means of screwdriver adjustment without change in resistance value, are suitable for use in transistor circuits where designer faces temperature-compensating problems. Model 760 "Temp-A-Just" wirewound resistors are available in sample quantities at $15 each. Manufacturer: Conrad-Carson, Inc., 3100 Goddard Way, San Diego 1, Calif.

• **Transistor overload circuit breaker** protects transistors against damage due to current overload, short circuits, thermal runaway and overvoltage punch-through. Device provides load current detection sensitivity of 200 ma. at 20 amperes load and a turn-off time of less

B-70's high speeds and tremendous cooling loads pose the most demanding environment control problems ever encountered

At 2,000 mph, skin temperatures of the USAF/North American B-70 will soar as high as 600°F. Yet the crew and avionic gear will function in ideal temperatures—from sea level to 70,000 feet.

To solve the plane's extraordinary operational requirements, Hamilton Standard is developing the most advanced and comprehensive environment conditioning system ever planned for an aircraft. It will provide completely automatic . . .

- cooling and pressurization of avionic gear and crew compartments
- emergency ram-air cooling and pressurization
- temperature control for drag-chute and landing-gear compartments
- moisture removal
- air-contaminant control

MAIN COOLING for crew and avionic compartments is provided by a closed vapor-cycle/air recirculation system and several closed-loop transport systems.

THE B-70 PROGRAM is an excellent example of Hamilton Standard's unmatched systems capability in environment conditioning and control. It incorporates skills and experience the company has amassed in creating systems for such advanced aircraft as the F-104, F-105, B-58, 880 Jet-Liner and over 40 other leading military and commercial planes.

CLOSED-ENVIRONMENT CONTROL SYSTEMS for space vehicles are also under study at Hamilton Standard. Current research involves a variety of equipment, designed to remove and regenerate air contaminants from a sealed capsule. Object: to ensure a safe air supply for man in space.

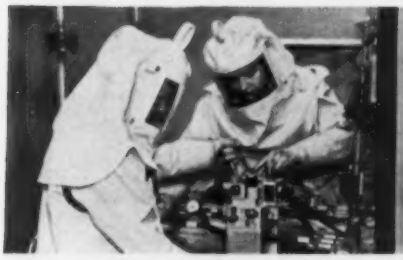
FURTHER INFORMATION on current Hamilton Standard environment programs and services is available. Your inquiry is invited.

HAMILTON STANDARD

DIVISION OF UNITED AIRCRAFT CORPORATION

WINDSOR LOCKS, CONNECTICUT

SOME OF THE MANY FIELDS OF GROWTH AT HAMILTON STANDARD



ENGINE CONTROLS for over 20,000 aircraft gas turbines have been produced by Hamilton Standard. The company's latest control work involves advanced rocket engines.

GROUND SUPPORT EQUIPMENT. Hamilton Standard is presently producing a wide range of GSE for both missiles and aircraft—from special tools to complete systems.

ELECTRONICS at Hamilton Standard includes broad experience in flight control, instrumentation, static power inversion and electrical control for aircraft, missile and GSE components.

(ADVERTISEMENT)

DATA AND CONTROL SYSTEMS

Young Company Surprises Industry and Competitors with Early Breakthroughs

Danbury, Conn.—A relatively young company, Data-Control Systems, Inc., has stolen the march on competitors with the production of the industry's first solid-state discriminator. In addition, the company has been in production for some time on a voltage-controlled oscillator, the AOV-3, which has been described as the "best in the industry", and a low level, smaller airborne oscillator, the AOV-10, which likewise appears to surpass anything currently on the market. Moreover, the company has just announced a new high impedance version of its electronic commutator, to meet the industry's coming requirements.

• **Data-Control Systems** was formed on October 1, 1957, just a few days before the announcement of Russia's Sputnik I. Since that auspicious day, the four original founders, including Dr. Robert J. Jeffries, a former president of the Instrument Society of America, have built an organization that today employs some 275 people. The Company's Research and Engineering Department, under the direction of Mr. Raymond A. Runyan, totals approximately fifty persons, and includes many of the country's outstanding designers of electronic data systems and measuring instruments.

Proprietary products include complete FM/FM telemetry airborne and ground systems including fixed and switchable subcarrier discriminators, reference oscillators, mixers, tape speed compensators, amplifiers, voltage-controlled oscillators, strain-gage oscillators, electronic commutators, calibrators, automatic standardization systems, sensing devices, data display devices and remote control links employing radio and wire transmission.

• **Several complete** ground-based data-acquisition systems designed and built by the young firm for the Boeing Airplane Company, Seattle, have just been delivered, and will be used for the R&D flight-test program of the "Minuteman" ICBM. Other customers of DCS include Aerojet-General, Arma, Chrysler, JPL, Lockheed, Douglas, North American Aviation, and Martin, as well as numerous military installations and university research centers.

• **The new solid state** FM/FM discriminator, Model GFD-3, exhibited at National Symposium on Space Electronics and Telemetry in Washington, D. C., is a logical outgrowth of the research in this field that DCS has pioneered from its very inception. For detailed information as to specifications, prices, etc., contact DCS directly: Dept. AW-10, East Liberty Street, Danbury, Conn.

DATA-CONTROL SYSTEMS INC. President, Robert J. Jeffries (left) checks installation of company's new transistorized subcarrier discriminator in Minuteman telemetry ground station just prior to shipment, while R. A. Runyan, V. P. of Research (right) and R. H. Hyde, Manager of Marketing, look on.

FOUR DCS PRODUCTS TERMED "WORLD'S FINEST"

Dr. Robert J. Jeffries, President of DCS, describes his company's latest breakthroughs in these words: "We honestly believe that the Discriminator, Oscillators and High Impedance Commutator just announced represent the finest instruments of the type available today, from both manufacturing and state-of-the-art standpoints. We are proud to add them to our growing list of standard products which are bringing new standards of performance to research instrumentation systems."

GFD-3: Solid state compact phase lock loop discriminator; low power consumption, high power out; highly linear; ultra stable; extreme reliability.

APC-2: Solid state electronic commutator; high input impedance; low noise and cross talk. Unique modular construction permits wide range of switch points and sampling rates.

AOV-3: Solid state miniature voltage-controlled oscillator; long term stability; max. linearity; low distortion over wide temperature range.

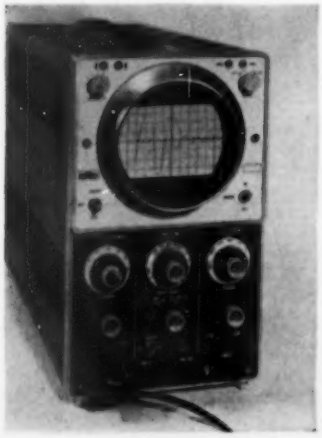
AOV-10: Millivolt solid state miniature voltage-controlled oscillator combines best performance of DC amplifier and VCO into simple economical plug in switch for strain gages, thermocouples, etc. Ultra stable over wide temp. range.

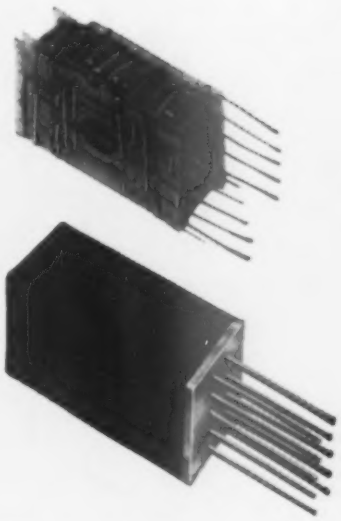
than one microsecond per ampere beyond selected break delay. Total response time to overvoltage is 50 microseconds. Controls on the CB-20 breaker permit selection of current limit from 2 to 20 amp., break delay time to allow for filament or capacitor inrush currents and selection of automatic or manual breaker reset. Manufacturer: Mallory Electronics Division, Indianapolis, Ind.

• **Miniature remote attenuator** operates at speed of 0.005 sec., weighs less than 3 oz. Device provides Type "N" straight-through coaxial co..nection when voltage (28 v. d. c. or 115 v. a. c., 400 cps.) is applied and becomes a 20-

db. bi-directional attenuator, usable from 50 mc. to 3,500 mc., when voltage is removed. Device reportedly meets MIL-E-5272C. Manufacturer: Don-Lan Electronics, Inc., 1131 Olympic Blvd., Santa Monica, Calif.

• **Storage-type oscilloscope,** Type 430, known as "StoreScope," permits display to be frozen for periods of minutes or days and erased when desired. Storage tube used employs a P10 phosphor which produces dark trace on a light background. Erasure requires a maximum of 15 seconds with a recycle every





how do you play the numbers game?

The current numbers game consists of seeing how many components you can wedge into a small space. But there's a catch to it.

Some circuit modules may seem small until you string them together and find that interconnections and supporting structure take more space than the modules themselves. That's why it's important, in evaluating miniaturization, not to consider the module size alone, but to be concerned with the over-all size, including module, interconnections, and supporting structure.

New EECO MINIWELD circuit modules are designed with **over-all** system size in mind. They offer optimum miniaturization not only of modules, but also of interconnections and supporting structure. Add to this the reliability of proven circuits incorporating readily available standard catalog components rather than hard-to-get specials, the superior strength of welded rather than soldered connections, and you have an unbeatable combination of advantages.

We invite you to see for yourself at Booth 402, New York ISA Show.

Write, wire, or 'phone today for detailed information on the revolutionary new MINIWELD space-saving package.

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3M Materials Memo

News of materials for the aerospace industry—selected from the 27,000 products of the 3M Company

Throw The Book At You?

Not this one! But we'll be happy to send you a copy if electrical casting resins are your diet. This particular book is actually a brand new reference manual on 3M's series of "Scotchcast" Electrical Resins. Its proud parent, our ELECTRICAL PRODUCTS DIVISION, would throw up its collective hands in horror at the mere thought of its being even considered a catalog. They've gone all out to insure that this manual will be an equally useful tool for old pro and tyro alike.

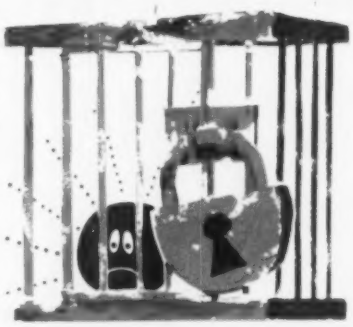
You'll find within the 28 pages heavy emphasis on techniques and tips for using casting resins. These cover such aspects as component design, molds and mold releases, resin storage and application, special equipment and all sorts of other "pointers for potters." Then there's the

guide to selecting the proper resins for given electrical applications. Beefing it up still further are tables of physical and electrical property data on the "Scotchcast" family of resins.

This book's a real collector's item. Why not cast off your electrical insulation problems by getting your own copy? Just check the box below.

Caged Radiation

If you've been anxious to put radioactive isotopes to work *for* you, but have been afraid they may end up working *on* you, this will be a welcome bit of news. These hot little personalities have been tamed in a way that makes them even more useful and yet substantially reduces the handling hazards. The isotope is literally caged in tiny ceramic beads, approximately 50 microns in diameter. The union between ceramic and isotope is actually a chemical bond which keeps



miscellaneous solvents, chemicals, and even the human digestive system from leaching out the radioactive material. Our CENTRAL RESEARCH LABORATORIES have refined the process to such an extent that they can now treat almost any of the radioactive isotopes.

The products, known as Radiating Microspheres, lend themselves well to a variety of industrial and medical applications. Being uniform in particle size, and free flowing, they can readily be incorporated in a variety of products. Their use in detectors for film thicknesses and densities or as tank level indicators is a natural, thanks to their chemical resistant overcoats.

Nor do the possibilities end there. Encased in suitable plastics, the Radiating Microspheres can form self-energized luminous instrument dials, signs, etc. Let our Central Research Laboratories tell you how Radiating Microspheres can brighten your future, too—by checking the box below.

■ Paper Shufflin'

It may seem mundane to talk about paperwork in the highly sophisticated aerospace industry, but correspondence is more than ever becoming the businessman's burden. Indeed, we wonder if a pound of hardware isn't accompanied by a pound of correspondence! There are two bad features about this nightmare of paperwork. One is the time required to handle it and the other is the space required to store it. Our DUPLICATING PRODUCTS DIVISION has come up with two time and space savings ideas to help you solve your paper work problems.

One of these is the fabulous "Filmac" Reader-Printer for reading Microfilm and making instant projection prints. It was described in an earlier issue.

The other is an idea called the Short Note Reply, and sometimes known as the SNR system. It works like this. You get a letter or memo which requires a short reply. Instead of dictating an answer and putting it into the steno pool, you simply write your answer at the bottom of the copy of the letter. A dry copy is then made on a "Thermo-Fax" Copying Machine and returned to the sender. You have the original for your files and he has a copy for his. After you've written your reply, the copying process takes only 4 seconds. For more information on this time saving method of handling correspondence check "Thermo-Fax" Copying Machine on the coupon below.

3M Company, Missile Industry Liaison–Dept. VAC-90
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Please send ☐ reference manual on "Scotchcast" Electrical Resins ☐ information on Radiating Microspheres ☐ facts on "Thermo-Fax" Copying Machine ☐ 3M Products for the Aerospace Age.

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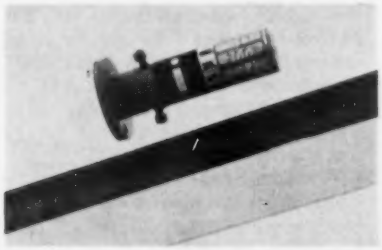
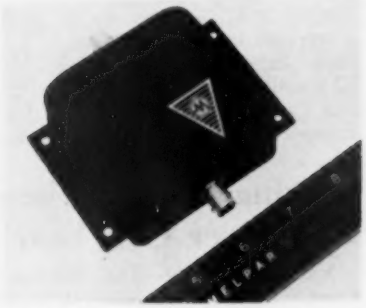
MISSILE INDUSTRY LIAISON

40 sec. Device can also be used as a conventional dynamic oscilloscope. Storage tube life is expected to average about 1,000 hr. Oscilloscope bandwidth is nominally 10 kc. in both axes, with spot size of 0.018 in. Writing speed is 30,000 cm./sec. Manufacturer: Allen B. Du Mont Laboratories Div., Fairchild Camera and Instrument Corp., 750 Bloomfield Ave., Clifton, N. J.



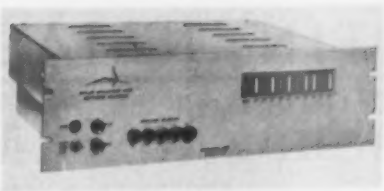
• **Inertia switch,** Model 6UO-115, will operate when subjected to preselected acceleration forces of 1g to 25g, within a tolerance of 5% of setting. Device has only one moving part, a precision steel ball held against a solid base by a uniform magnetic field that moves to close switch when subjected to acceleration. Switch reportedly meets MIL-E-5272 and operates over temperature range of −65F to 200F. Manufacturer: Inertia Switch, Inc., 311 West 42nd St., New York 36, N. Y.

• **Bandpass filters,** available in frequency range from 20 to 1,500 mc., occupy less than 13 cu. in. and weigh only 4 oz. Multi-stage filters have either maximally flat or Tchebycheff response characteristics, giving up to 35 db. signal rejection at one bandwidth from



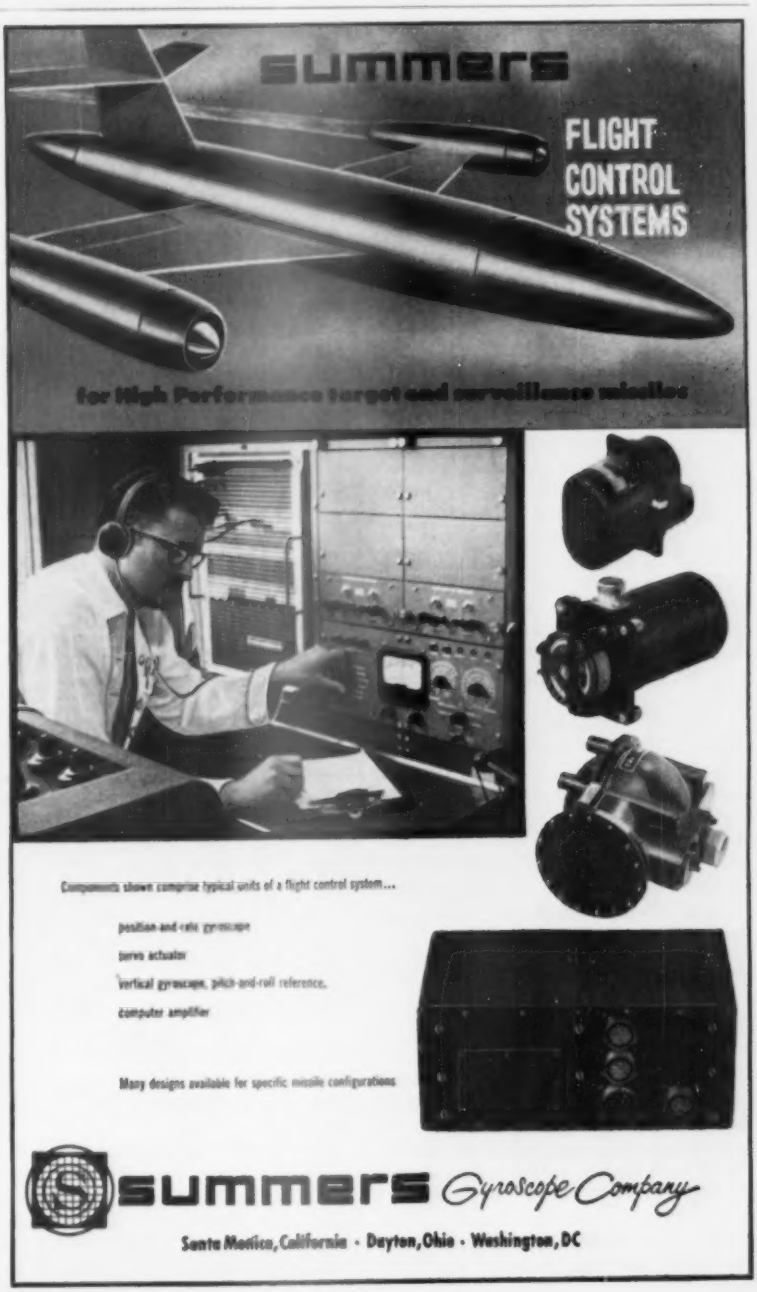
filter's center frequency. Bandwidths range from less than 5% to more than 20%. Maximum insertion loss in passband is less than 1 db. Filters are designed to meet MIL-E-5400 and MIL-E-5422. Manufacturer: Melpar, Inc., Special Products Dept., Alexandria, Va.

• **Low-cost digital computing unit,** Model 3-303, for data processing, instrumentation and control, performs digital computations in any arithmetical model. Unit provides 100 kc. serial



operation with typical speeds of 8,000 additions or 750 multiplications per second. Device includes internal programing and control, self-checking circuitry and power supply. It is designed for standard 19-in. relay rack mounting, with panel height of 5¼ in. and depth of 17 in. Price is $4,550 FOB Los Angeles. Manufacturer: Applied Development Corp., 12838 Weber Way, Hawthorne, Calif.

• **Subminiature accelerometer** Model 606, piezoelectric type, measures only ¼-in. high and weighs only 1 gram. Frequency response is 5 cps. to 10 kc., with resonant frequency of 135 kc. Maximum acceleration is 40,000g, with amplitude linear to within 2%. Operating temperature range is −65F to 300F, or up to 500F on special order. Manufacturer: Columbia Research Laboratories, MacDade Blvd. and Bullens Lane, Woodlyne, Pa.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Fund Changes Show Mixed Market Climate

New York—Investment trusts continued to look pessimistically at aviation and airline stocks in the second quarter for the most part, but there were exceptions that foreshadowed the somewhat improved climate for industry shares that has continued into September.

National Aviation Corp., a closed end investment trust specializing in aviation, began to rebuild some of its holdings in airlines during the second quarter after a series of cutbacks that culminated in the first quarter.

In the airline field, National had reduced its holdings in American Airlines to 25,000 shares in the first quarter and its United Air Lines holdings to 20,000 shares.

In the second quarter it bought back 10,000 shares of American and 7,500 shares of United. It also increased its holdings in Eastern Air Lines to 22,000 shares.

National eliminated its holdings of Thiokol Chemical Corp. and Marquardt Corp. in the second quarter, and had eliminated General Dynamics Corp. during the first quarter. Lockheed Aircraft Corp. holdings were reduced 16,230 shares, but the investment trust continued to hold 13,770 shares in its portfolio.

Relating specific fund transaction to market climate for a particular company or industry, however, only follows to a degree. National Aviation, for example, sells off portions of the rapid growth side of its portfolio as a profit taking measure.

Another probable example of this technique can be found in the accompanying table, which shows frequent sales in the electronics section by Television-Electronics Fund, a Chicago company which has mushroomed with the volatile market in shares of companies in this field. Television-Electronics lightened many of its holdings but seldom eliminated any.

National Aviation Holdings

Perhaps more significant to general industry outlook is the fact that, of 24 closed end investment companies surveyed by the National Assn. of Investment Companies, National Aviation had the largest percentage of its assets—24.8%—invested in cash and government securities as of June 30 and had the lowest proportion of common stock—63.8%.

National Aviation found the increase in government bond holdings was fortunate timing, for the increase in interest it received in the first half more than offset the declines in cash dividends resulting from dividend cuts or omissions by such companies as United Aircraft and Douglas.

According to the E. F. Hutton report, from which the table is reproduced, selling predominated in aircrafts, though there are several exceptions in individual companies. Airline selling subsided, the report noted, but was not followed by any buying sentiment.

After a brief rise when the Civil Aeronautics Board indicated its rate-of-return position, airline stocks have acted listlessly, though no further substantial price drops have occurred.

Defense stocks have rebounded from their lows because of pledges of increasing military strength by candidates and because of improved earnings. Paradox is still the rule, however. Lockheed—which reported a $55 million first half net loss because of extensive writeoffs—actually rose in price on the announcement.

Wall Streeters were calling Lockheed Chairman Robert E. Gross's presentation of the bad news to the New York Society of Security Analysts (AW Aug. 15, p. 51) the "financial public relations coup of the year."

Issuance of the Federal Trade Commission-Securities and Exchange Commission quarterly report and some additional first half or fiscal year reports has thrown further light on the financial state of the industry.

Profit Margins Low

Profit margins for what the report classes as the aircraft and parts industry continue to remain below manufacturing industries as a whole. Sales margins from a low of 1.3% in the third quarter of 1959 rose to 1.5% in the fourth quarter, and dropped to 1.4% in the first quarter of 1960. Only apparel makers showed lower margins. Margins on net worth rose from 6.8% in the third quarter of last year to 8% in the fourth quarter, but dropped back to 7.2% in the first quarter of this year. (Figures are synthesized from federal income tax returns and computed for each quarter to put the figure for that quarter on an annual basis.)

First quarter sales totaled $3.1 billion, a 12% increase over the first quarter of 1959, but a 5% drop over the last quarter of that year. After-tax profits amounted to $45 million, a 13% drop compared with the first quarter of 1959 and an 8% drop from the fourth quarter.

Less detailed SEC figures just compiled for the second quarter show industry sales rose as compared with both the first quarter of 1960 and the second quarter of 1959. Profits—listed as $45 million—were down from the $54 million in the previous second quarter but were the same as computed for the first quarter of 1960.

Based on SEC's second quarter sales figure of $3,283 million for the industry, this works out to an average profit margin on sale of 1.3%.

Latest financial reports:

• **McDonnell Aircraft Corp.** reported a 20% increase in earnings for its fiscal year ended June 30. On sales of $436,981,100, the company earned $12,087,025 or $3.55 a share compared with sales of $435,878,979 and earnings of $10,037,995 or $2.94 a share the year before. Profit margin on sales rose from 2.3% to 2.7%.

President J. S. McDonnell reported that the F4H Phantom II is in final test phases with the Navy and is expected to be delivered to fleet training squadrons in October. The Quail decoy missile has completed Category II USAF testing and is being delivered to SAC.

• **General Dynamics Corp.** reported sales increased to $979,750,082 in the first half compared to $804,296,996, but that net income dropped from $15,194,383 or $1.53 a share for the period a year ago to $12,095,151 or $1.22 a share. Increased interest expense, from $2.5 million a year ago to $5.2 million, and Convair 880/600 commercial jet transport write-offs accounted for drop.

Marquardt Sales Show Gain Over Last Year

Van Nuys, Calif.—The Marquardt Corp. had sales of $36,318,093 for the 28-week period ended July 17, up 7% over the comparable period a year ago, Roy E. Marquardt, president, reported today. Sales for the like period in 1959 were $34,051,091.

Net earnings for the 28-week period this year amounted to $599,597, equal to $0.43 per share on the average number of shares outstanding. This compared with net earnings of $860,647 or $0.65 per share for the comparable period in 1959.

Marquardt projected sales for 1960 as a whole as approximating the volume

Portfolio Changes in Aerospace Stocks

Source E. F. Hutton Co.

Aerospace

PURCHASER	BOUGHT	NOW HELD	COMPANY
			Aerojet-General
National Investors Corporation	11,000†	11,000	Beech Aircraft
			Bendix Corporation
			Boeing Airplane
Diversified Growth Stock Fund	25,000†	25,000	Cessna Aircraft
			General Dynamics
			Grumman Aircraft Engineering
			Lockheed Aircraft
			Marquardt Corporation
Affiliated Fund, Inc.	25,000	70,000	Martin Company
Madison Fund, Inc.	10,000†	10,000	
Investment Company of America	30,000†	30,000	North American Aviation
National Aviation	3,000	17,500	Northrop Corporation
Diversified Growth Stock Fund	15,000†	15,000	Piper Aircraft
Dreyfus Fund, Inc.	11,000	33,000	
National Investors Corporation	10,700	13,000	
			Thompson Ramo Wooldridge
National Aviation	10,000	17,500	United Aircraft

SELLER	SOLD	NOW HELD
Television-Electronics Fund	5,500	40,900
Broad Street Investing Corp.	2,100*	
Fidelity Fund, Inc.	26,800	14,600
Selected American Shares, Inc.	2,400	36,300
Bullock Fund, Ltd.	7,200	14,000
Dividend Shares, Inc.	7,600	17,900
Investment Trust of Boston	4,000*	
Madison Fund, Inc.	3,000*	
National Aviation	9,230	13,770
National Aviation	7,500*	
United Science Fund	9,200	40,000
United Science Fund	6,300*	
Television-Electronics Fund	1,000	42,000
Delaware Fund, Inc.	2,000	10,000
Dominick Fund, Inc.	5,000*	
Financial Industrial Fund	5,000	5,000
Colonial Fund, Inc.	5,000*	
Selected American Shares, Inc.	10,000*	
United Income Fund	7,000	23,000
United Science Fund	2,000*	

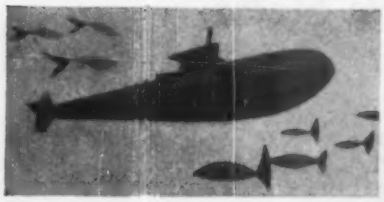
Electronics and Electrical Equipment

PURCHASER	BOUGHT	NOW HELD	COMPANY
			Admiral Corporation
			American Electronics
Dominick Fund, Inc.	5,500	8,500	Ampex Corporation
			Amphenol-Borg Electronics
Putnam (George) Fund of Boston	20,000†	20,000	AMP, Inc.
Dreyfus Fund, Inc.	15,000	30,000	Beckman Instruments
Dreyfus Fund, Inc.	2,500	7,500	Collins Radio
			Cutler-Hammer
			Electronic Associates
			Emerson Electric
United Science Fund	4,000	5,000	Fairchild Camera & Instrument
Broad Street Investing Corp.	2,900	16,000	General Electric
Fidelity Fund, Inc.	15,500†	15,500	
Dreyfus Fund, Inc.	4,000	20,000	General Precision Equipment
			Giannini Controls
			General Time
			Hazeltine Corporation
			Hewlett-Packard
Colonial Energy Shares	1,300	2,400	High Voltage Engineering
			Hoffman Electronics
			Indiana General
Putnam Growth Fund	15,000†	15,000	Interstate Engineering
			I-T-E Circuit Breaker
			Laboratory for Electronics
Colonial Energy Shares	3,500	10,000	Leeds and Northrup
Diversified Growth Stock Fund	50,000†	50,000	Ling-Altec Electronics
			Litton Industries
Selected American Shares, Inc.	2,100	12,100	Magnavox
United Accumulative Fund	17,000	60,000	McGraw-Edison
Diversified Growth Stock Fund	3,000	10,000	Motorola
			Philco Corporation
Madison Fund, Inc.	10,000†	10,000	Philips Electronics & Pharmaceutical
			Philips Lamp
United Income Fund	4,000	10,000	Radio Corporation of America
Selected American Shares, Inc.	1,600	6,600	Reliance Electric & Engineering
Dreyfus Fund, Inc.	6,000	26,000	Siegler Corporation
Dreyfus Fund, Inc.	17,500†	17,500	Siemens & Halske
Broad Street Investing Corp.	34,900	40,000	Square D Company
Commonwealth Investment	2,000	5,000	
Selected American Shares, Inc.	10,000	25,000	
			Technology Instrument
			Telecomputing Corporation
Dominick Fund, Inc.	500	2,000	Texas Instruments
Diversified Growth Stock Fund	15,000	50,000	Transitron Electronics
Television-Electronics Fund	100,000†	100,000	Triangle Conduit & Cable
			Universal Controls
			Varian Associates
Colonial Energy Shares	9,000†	9,000	Westinghouse Electric
National Investors Corporation	15,000†	15,000	Zenith Radio

SELLER	SOLD	NOW HELD
Television-Electronics Fund	1,600	45,000
Television-Electronics Fund	7,000*	
Delaware Fund, Inc.	21,500*	
Madison Fund, Inc.	7,500*	
Television-Electronics Fund	5,600	154,400
United Science Fund	6,000	29,000
Television-Electronics Fund	2,100	17,900
United Science Fund	2,000	10,000
National Aviation	3,000	10,000
National Investors Corporation	20,800*	
Broad Street Investing Corp.	5,000*	
Television-Electronics Fund	4,000	20,600
Television-Electronics Fund	1,025	17,000
Television-Electronics Fund	11,000	60,000
National Aviation	1,200	8,800
United Science Fund	22,000*	
United Science Fund	15,900	9,800
National Aviation	1,000	6,500
Television-Electronics Fund	3,000	20,000
National Aviation	7,500*	
Television-Electronics Fund	3,900*	
Broad Street Investing Corp.	22,000*	
Tri-Continental Corporation	30,000*	
Television-Electronics Fund	2,500	5,000
Television-Electronics Fund	2,777	20,000
Television-Electronics Fund	12,300	95,000
United Science Fund	5,000	25,000
Bullock Fund, Ltd.	5,000*	
Commonwealth Investment	400	2,300
Delaware Fund, Inc.	6,500*	
Dreyfus Fund, Inc.	2,700*	17,300
Dreyfus Fund, Inc.	2,500	29,500
United Continental Fund	1,025	10,000
Affiliated Fund, Inc.	10,000	50,000
Commonwealth Investment	4,000	7,260
Delaware Fund, Inc.	5,600	2,000
Dividend Shares, Inc.	2,200	30,000
Dreyfus Fund, Inc.	4,740	2,400
Investment Company of America	2,000	18,400
Lazard Fund, Inc.	36,500	40,000
Selected American Shares, Inc.	16,500	24,500
Television-Electronics Fund	7,800	75,300
Diversified Growth Stock Fund	25,500*	
Television-Electronics Fund	5,000	20,000
Institutional Growth Fund	3,900	10,800
Madison Fund, Inc.	3,000	20,000
United Science Fund	1,000	6,000
Delaware Fund, Inc.	1,090*	
United Continental Fund	2,100	9,000
Television-Electronics Fund	3,000	30,000
Financial Industrial Fund	16,200	15,800
Investment Trust of Boston	12,600*	
Dreyfus Fund, Inc.	12,500	1,500
Television-Electronics Fund	2,400	105,000

† New Commitment * Complete Elimination

from under the seas . . . to the edges of space . . . and beyond



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Vāp-Air Mercs have many uses, widespread acceptance

Used in:
Titan, Thor, Jupiter, Redstone, Saturn, Juno II, Pioneer IV, and other missiles; X-15 Space Research Vehicle; F-106 Delta Dart, A3J Vigilante, P6M-2 Seamaster, F101B Voodoo and A4D-2 Skyhawk, and other military aircraft; Nautilus submarine; ground support vans and equipment; the new Electra, F-27, Viscount, DC-8, 707, and 880 jets, as well as most other major commercial aircraft.

Used for:
Temperature control of electronic compartments, reference ovens, crystal ovens; nose-cone devices; gyroscopes; inertial guidance system; accelerometers; air compressors; turbines; cabins, cockpits, capsules; windshields; de-icing equipment; oil, fuel, hydraulic systems; for telemetering of temperatures; for control systems, and as warning devices in ground support vans and equipment; and many other uses.

have proved outstandingly accurate and dependable for the most critical thermal sensing and control applications in missiles, aircraft, ground support and undersea equipment.

The Army Ballistic Missile Agency has for two years accepted Merc thermostats as standard temperature control items on all their missiles.

Time after time, Vap-Air mercury tube thermostats have proved their exceptional ability to meet the most exacting specifications for thermal sensing and control. Small, lightweight, they are unaffected by altitude or moisture, can't arc or burn, can withstand 100-G shocks and 30-G vibration without loss of accuracy. They have fast response, close limit tolerances, wide operating ranges, and undeviating accuracy to provide millions of cycles of reliable operation. Mercs need only simple circuits, are adaptable to virtually any need.

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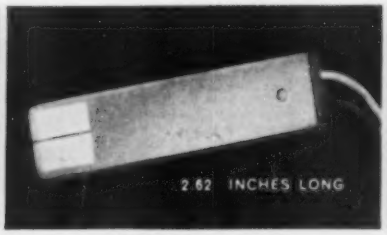

SURFACE-TYPE

WELL-TYPE

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Three standard groups: (1) Well-type, for sensing case temperatures, (2) Duct-type, for gas or fluid temperature, (3) Surface-type, for "area-contact" temperature sensing. Can be ordered direct from catalog. Complete, ready to mount. Meet military specification MIL-E-5272 A. Write for Bulletin No. 684.

For special needs, Merc thermostats can be adapted or designed to meet your specifications.

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of the previous year. Total sales for 1959 were $69,011,255.

Marquardt said operations of the Pomona Division have progressively improved, with that division having recently entered a new area of application for its trainer equipment for on-ground training of personnel in the launching operations of air-to-surface missiles and decoys.

With respect to the Bomarc ramjet engine program, he said that the national defense appropriations bill as finally approved provides funds to continue production at the Ogden Division until mid-1961. Bomarc engine development work at Van Nuys will be completed by the end of this year.

Marquardt emphasized that the company's efforts are being concentrated on the development of new programs to replace the Bomarc program as it phases out at Van Nuys and later at Ogden.

"One result of such efforts has already been obtained in a contract for the development of a new ramjet engine for an Army target drone. This program is of particular significance in that it provides a new application for the ramjet engine as well as a new user of our product—the U.S. Army."

AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

David Clark Co., Inc., Worcester, Mass., light weight pressure helmets for an unknown use, (PR 86144), $69,389.

Giannini Controls Corp., Pasadena, Calif., transmitter, synchro, angle of attack or sideslip, Aerno 60-1603, 156 ea., for support of F-101B, F-105B/D and F-106A/B aircraft, IFB 33-600-60-198, (PR's SA-0-05C-C10189, ES-O-6610-6987 and MA-0-05C-933), $67,080.

Lear, Inc., Grand Rapids, Mich., Phase I, VGI components: gyrascope, displacement, roll and pitch, type MD1, Aerno 60-5937, 2,740 ea.; indicator, attitude, remote, type MM-4A, Aerno 60-5940, 976 ea.; indicator, attitude, type MM-3A, Aerno 60-5939, 2,041 ea., maintenance and engineering data for use as installations and spares on B-42, F-100, F-101 and F-102 aircraft, (PR's SA-0-6610-C11770 and amendment 1; SA-0-6615-C11771; SM-60-05C(F100)-6356; MA-0-05C-1032; 00-0-1AGU-6062-5631), 3,-782,279.

Westinghouse Electric Corp., Dayton, Ohio, power supplies P/N 904J027-2, FSN 6130-701-9048, 29 ea. for use as spares on C-130B aircraft, (PR ES-0-6130-6726), $37,-898.

Propeller Division, Curtiss-Wright Corp., Caldwell, N. J., power unit assemblies, FSN 1610-591-6414, contractor's P/N 158512,3 ea.; motor and contractor assembly, FSN 6105-594-1263, contractor's P/N 159570, 15 ea.; motor and brake assembly, contractor's P/N 161700-2, 24 ea. (propeller equipment for the Navy's ZPG-3W airship), MIPR R57-5763-173-NOas), $87,808.

Pioneer Central Division, Bendix Aviation Corp., Davenport, Ia., gyroscope, rate switching, type MC-1, contractor's model 15826-1-A, FSN 6615-618-9800, Aerno 60-5938, 3,452 ea., component of Phase II VGI system for B-52 F-100, F-101 and F-102 aircraft, (PR's SA-0-6615-C11771; SM-60-05C(F100)-6350; MA-0-05C-1243; MA-0-05C-1032; 00-0-1 AGU-6062-5631), $564,748.

Lumen, Inc., Joliet, Ill., 16 mm. motion picture sound projector, type AQ-3, 435 ea., 16mm. motion picture projector, type AQ-2A, 80 ea. and instruction books for ground support equipment (incl. as'd option), (MIPR's R60-07437-SPCC and amendment 2, and R60-30104-150-USMC and amendment 1), $256,490.

Kropp Forge, Inc., Chicago, Ill., dismantling and preparing for storage heavy hammer, (PR BI-10-S-9010), $31,000.

West Coast Missile and Surface Radar Division, Radio Corporation of America, Los Angeles, Calif., indicator, IP-58-APN-70, 274 ea., a component of the APN-70 loran navigation set, end use is USAF spares, (PR MD-0-5826-16048), $65,074.

GPL Division, General Precision, Inc., Pleasantville, N. Y., amplifier, electronic control, AM-946-A-APN-89A, Aerno 81-0194, 44 ea., for initial support of B-52H aircraft, (PR MD-0-5841-16195), $114,400.

Small Aircraft Engine Department, General Electric Co., West Lynn, Mass., J85-GE-7 turbojet engines in accordance with contractor's engine specification No. GE-1031C dated Dec. 21, 1959, 54 ea., and data for use in GAM-72A installation, (PR's EP-0-2840-6868 and EP-0-2840-7120), $3,-456,000.

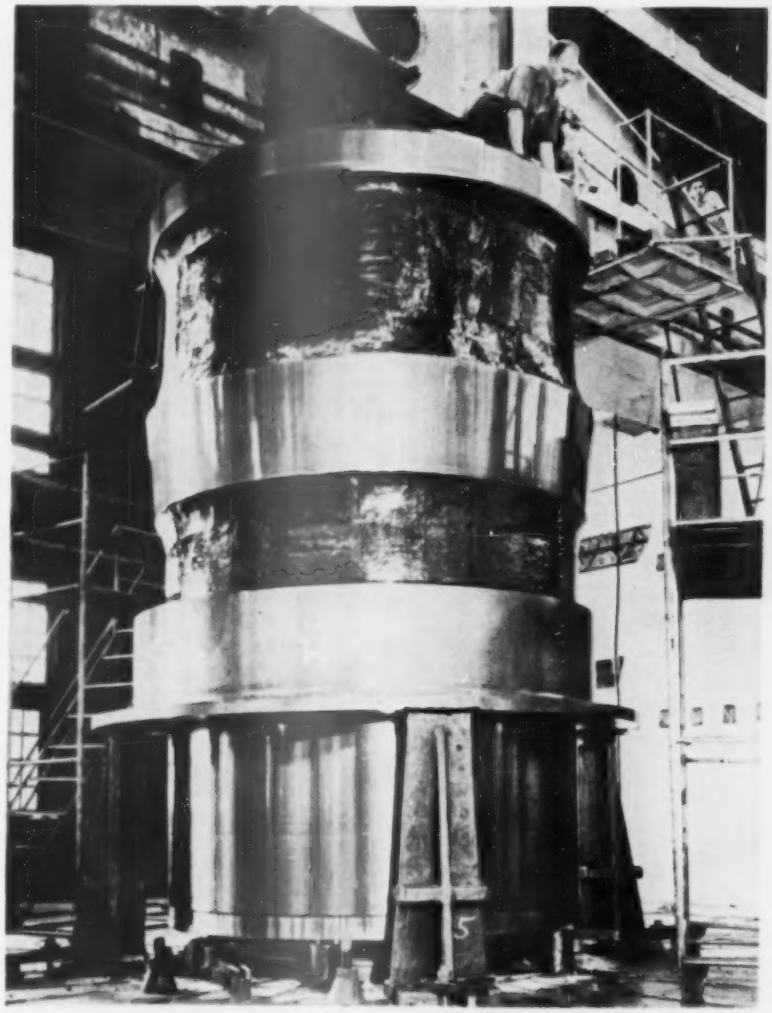
Tapco Group, Thompson Ramo Wooldridge, Inc., Cleveland, Ohio, tungsten forging program, (PR BM-0-MMP-9045), $197,-615.

Logetronics, Inc., Alexandria, Va., 6740-NLSP10-70 contact printer photographic contractor's model SP10/70, 14 ea.; 6740-NL-05543 optics for 70 mm. film, 14 ea.; 6740-NL05540 optics for 5½ in. film, 14 ea.; 6740-NL03920 standard spare parts kit, 14 ea.; 6740-NL07473 stepdown transformer, 14 ea.; handbook data for use as ground support equipment, (PR MO-60-6740-30001), $276,-635.

Thompson Products Division, Thompson Ramo Wooldridge, Inc., Cleveland, Ohio, laboratory model system for fuel cell, (PR 92006), $141,259.

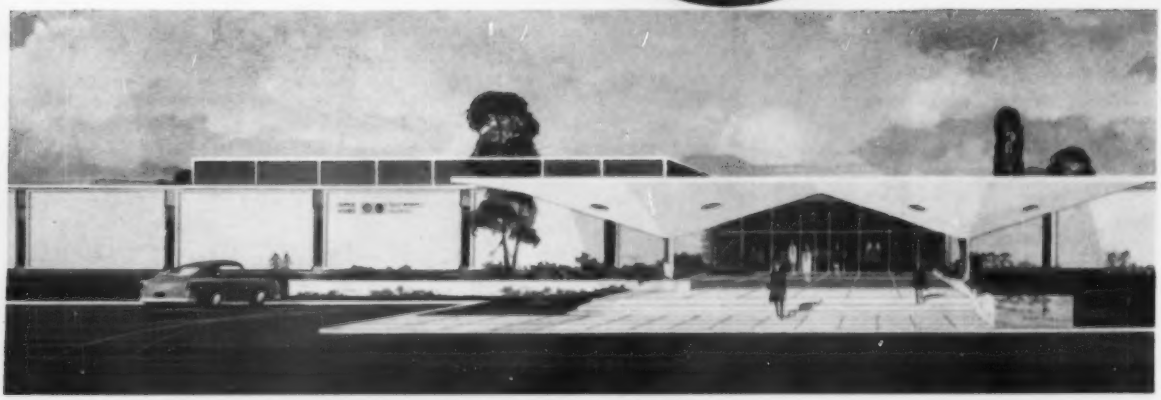
Weston Instruments Division, Daystrom, Inc., Newark, N. J., indicator, course, distance-track, ID-390A-ASN-7 (used with the navigational system AN-ASN-7), 50 ea. for use on C-130A, KC-135A and T-39 aircraft, (PR's WR-0-6605-5466, SA-9-FSC-6605-10118 and amendment a and MA-0-05A-564), $65,600.

Defense Products Division, Fairchild Camera and Instrument Corp., Syosset,



Shaft for Navy's 'Big Dish' Telescope

Shaft weighing 120 tons will be the turning point for Navy's 600-ft. "Big Dish" rotating radio telescope. Shaft measures 9 ft. in diameter and is 15½ ft. high. Mounted on the shaft and being machined on a large boring mill is a six-ton flanged wedge ring which seats the shaft in the main bearing base. Baldwin-Lima-Hamilton Corp. is building the entire base structure at its Eddystone, Pa., facility.



NEW $3,500,000 FACILITY ANNOUNCED BY VOUGHT ELECTRONICS

On July 21, Vought Electronics broke ground for a new $3.5 million facility in the Great Southwest Industrial District, midway between Dallas and Fort Worth. Completion date for the ultramodern 80,000 square foot building is January 1961, with expansion to 175,000 square feet projected within the next few years.

Complete Electronics Facility The completely self-contained facility will house engineering, assembly and manufacture, quality control, marketing, finance and administrative areas. Also included will be five laboratories — inertial guidance, servomechanism, fluids, microwave and environmental — all with advanced equipment.

Diversified Products Recent major Vought Electronics contracts include: production of actuators for the *Minuteman* ICBM, factory check-out equipment for the inertial guidance system of the *Titan* ICBM, guidance systems and autopilots for the new *Crusader* F8U-2N fighter.

B. H. Ciscel, general manager of Vought Electronics (left) and A. G. Wynne, Jr., president of Great Southwest Corporation, check details of new facility.

Among other new products are an aircraft navigational system, space vehicle guidance units, ASW devices, advanced antennas, a commercial fingerprint identification system.

FOR COMPLETE INFORMATION ON HOW THE NEW VOUGHT ELECTRONICS FACILITY CAN SERVE YOU, write:

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Boeing Builds B-52H Electrical System Mockup

Portion of complete a.c. and d.c. electrical power distribution system mockups for the Boeing B-52G and the new B-52H missile bombers are shown in Electrical and Electronic Design Laboratory at Boeing's Wichita Division facility. Work is centered on evaluation of the 120 kva. system for the B-52H. Test system includes complete aircraft d.c. power system including load simulation capabilities.

N. Y., conversion of type LA-8 to type K-17-D camera bodies, 63 ea., for use on B-52 aircraft, (PE ES-0-6760-6680), $41,616.

Clothing Division, United States Rubber Co., Washington, Ind., mobility joints, (PR 86146), $27,907.

Meipar, Inc., Falls Church, Va., development and fabrication of advanced trainer, Bullpup, ground, pilot, GAM-83A/B, engineering data, specifications and data, (PR's 56936 and EM-0-RD-7190), $417,347.

John Oster Manufacturing Co., Inc., Racine, Wis., amplifier, temperature, synchro signal, type ASU-1/A, contractor's P/N 9616-03, Aerno 61-8859, 126 ea. for use on C-133B MTU installation and replenishment spares for USAF, REP MA-0-05D-569 (HV), (PR's MA-0-05D-569(HV) and ES-0-6620-7083), $57,972.

Viewlex, Inc., Long Island City, N. Y., 6740-623-0027 roller assemblies, contractor's drawing P/N EH5-0130, 226 ea. and 6740-623-0029 lower roller rack assemblies, contractor's part/drawing Nr. EH5-0118, 120 ea. for the EH5 processing machine, ground support equipment, (MIPR's R60-32332-SC-24 and R60-32332-SC-23), $29,376.

Delco-Remy Division, General Motors Corp., Anderson, Ind., silver oxide-zinc battery program, (PR 92008), $120,000.

Delta-F, Inc., Geneva, Ill., crystal oven, HD-244/U, 6 ea., and data for use in GAM-77, (PR EC-0-16A-6922), $38,068.

General Electric Co., West Lynn, Mass., indicator, rate of flow, fuel, totalizing, type MA-7, FSN 6620-551-2631, Aerno 61-2463, 349 ea. and indicators, rate of flow, fuel, totalizing, type MA-8, FSN 6620-551-1270, Aerno 61-2462, 133 ea., for use in installations and spares of C-130 and C-133 aircraft, (PR's MA-0-05D-1149; MA-0-05D-1150; ES-0-6620-6988), $235,354.

Los Angeles Division, North American Aviation, Inc., Los Angeles, Calif., flight testing of the F-100F aircraft, (PR 63468), $125,000.

Aviation Products Division, The B. F. Goodrich Co., Akron, Ohio, pressure oxygen helmets, (PR 86207), $26,639.

Eclipse-Pioneer Division, Bendix Aviation Corp., Teterboro, N. J., propulsion monitoring system, 2 ea., and data for use on multi-engine aircraft, (PR 63384), $275,000.

Defense Products Division, Fairchild Camera and Instrument Corp., Syosset, N. Y., photographic reproduction system and related data, (PR C-4262), $3,150,118.

Telecomputing Corp., North Hollywood, Calif., coder, transponder, KY-9A/APX, FSN 5895-571-4504A, Aerno 81-1911, 2,451 ea. and control, coder group, C-1128/APX-25, FSN 5895-338-3991A, Aerno 61-2280, 2-267, for use on RT-33A, F-86D, C-121D, SH-21B, F-100A and C-54 aircraft, IFB 33-600-60-188, (PR's MD-0-5895-17051; MD-0-5895-17044; SM-0-16KL-6233; SM-0-16KL-6243), $779,742.

Kidde Aero Space Division, Walter Kidde & Co., Inc., Clifton, N. J., static circuit control devices, (PR 92016), $107,417.

Peninsular ChemResearch, Inc., Gainsville, Fla., synthesis of pilot quantities on monomers, (PR 98502), $26,161.

The Magnavox Co., Fort Wayne, Ind., component parts of radio set AN/ARC-34 and related data for use on B-52 aircraft, (PR MD-0-5821-16333), $25,135.

Alexandria Division, American Machine and Foundry Co., Alexandria, Va., airfield lighting control systems, (PR 99857), $41,543.

Southern, Waldrip and Harvick Co., Long Beach, Calif., construction of two (2) SHU-3/F aircraft maintenance docks, (PR EM-0-F-7032, IFB 33-600-60-211), $349,894.

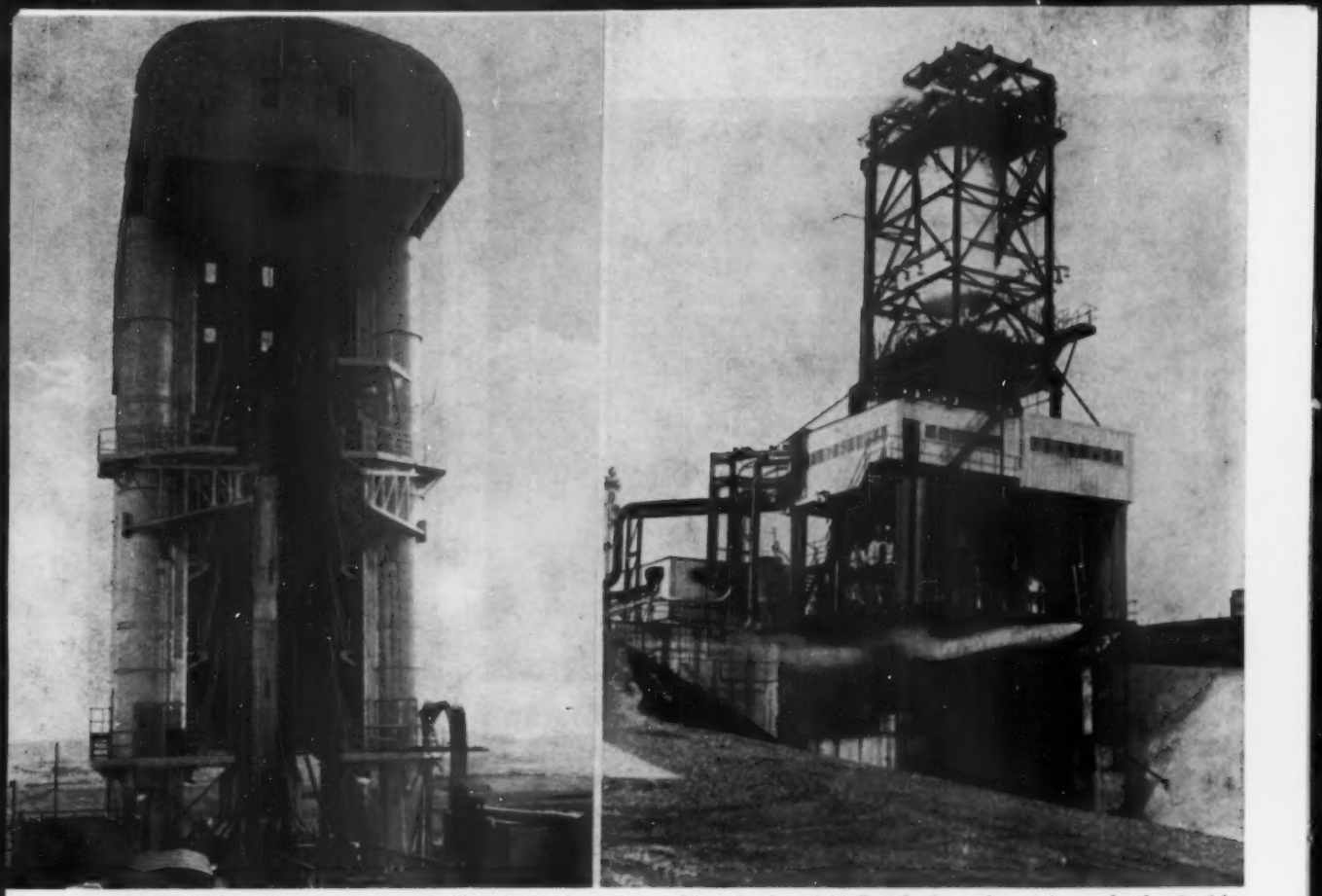
Airborne Accessories Corp., Hillside, N. J., voltage regulated transformer rectifier, 10 ea., for an unknown use, (PR 85552), IFB 33-600-60-179, $28,000.

Hughes Aircraft Co., Culver City, Calif., engineering services and supplies for F-106/MA-1 SAGE integration program, (PR DC-0-11B-4083), $75,000.

Federal Systems Division, International Business Machines Corp., Oswego, N. Y., increased work scope on management of AN/ASQ-38 systems program, (PR EG-9-11A-4774 and amendment 1), $118,341.

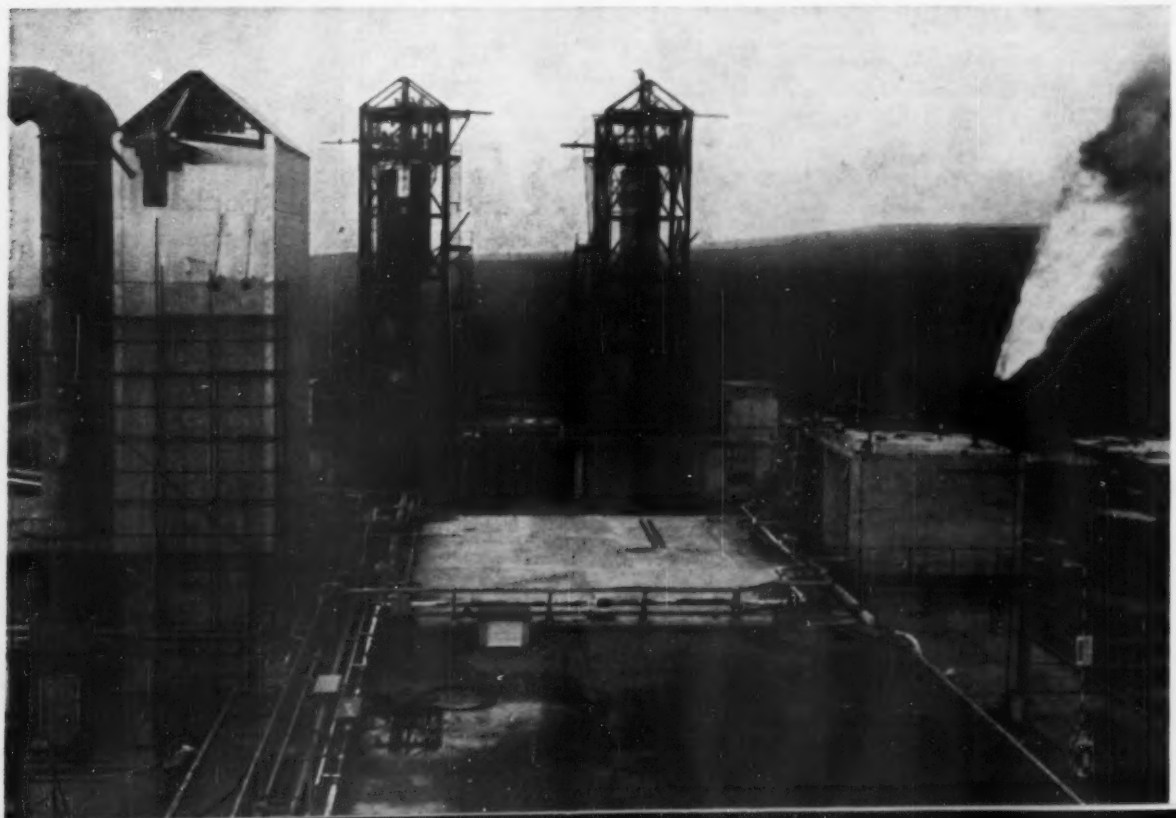
General Dynamics Corp., San Diego, Calif., joint Air Force/contractor flight test program for F-106 aircraft, (PR DG-9-1510-7228), $500,000.

Chicago Aerial Industries, Inc., Melrose Park, Ill., camera assemblies, type KD-2, 144 ea. for usage unknown, (MIPR 17-60-6003-WEPS), $79,257.



TEMPORARY missile servicing tower provides a facility for static test firing of rockets (left). Faired columns house nitrogen bottles. At right, engines are being readied for a test run. Installation simulates static head pressures of propellants.

TURBOPUMP test towers work on a regenerative cycle. Gas generator test cells (right) have been mothballed. Turbopump tower (left), which contains an early model of an Avon turbojet engine for driving propellant rotor system, has not been used.



Blue Streak Motor Records 300 Firings

By John Tunstall

London—More than 300 test firings of Blue Streak's RZ 2-Mk. 2 rocket motor were successfully made at the Spadeadam rocket test and development establishment before cancellation of the Blue Streak missile program last April.

These are known to have included a number of firings with durations of 2½-3½ min. of the twin rocket installation. At least one run has been made in recent weeks of considerably longer duration to prove the capacity of the rockets to meet a space vehicle launching requirement.

At peak periods consumption of liquid oxygen reached 100 tons a day—the peak capacity of the tonnage oxygen production plant installed on the site.

In spite of the cancellation, test firings have been continuing at a reduced rate of between three-five a week, but testing of the gas generator and other components has been stopped and tests of the gas turbopump unit are being concluded, pending a government decision on a British space program.

Engineers here said that in effect development work on the current Mk. 2 engine had been satisfactorily concluded and that the cutback in component development work concerned late models of the motor.

First Firing

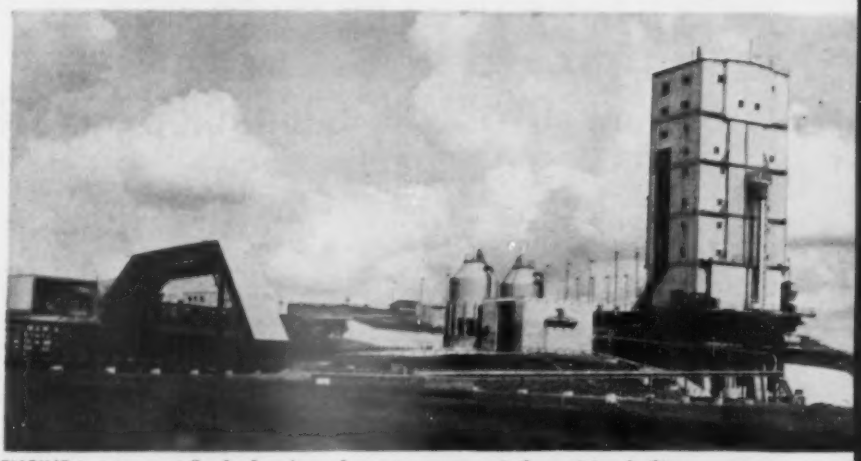
The vehicle was recently given its first public test firing at Spadeadam but after a successful firing sequence the two 135,000-lb.-thrust motors were automatically shut down after barely registering a crackle. Cutoff was triggered by "red-line" monitors operating on the major temperature, pressure and flow parameters.

In this test the offending parameter was the pressure buildup in one of the propellants' supply lines. But the same engines were successfully ignited two hours later and ran for 2½ min.

According to the test engineers it was only the second premature cutoff in the last 30 firings of a twin-engine configuration.

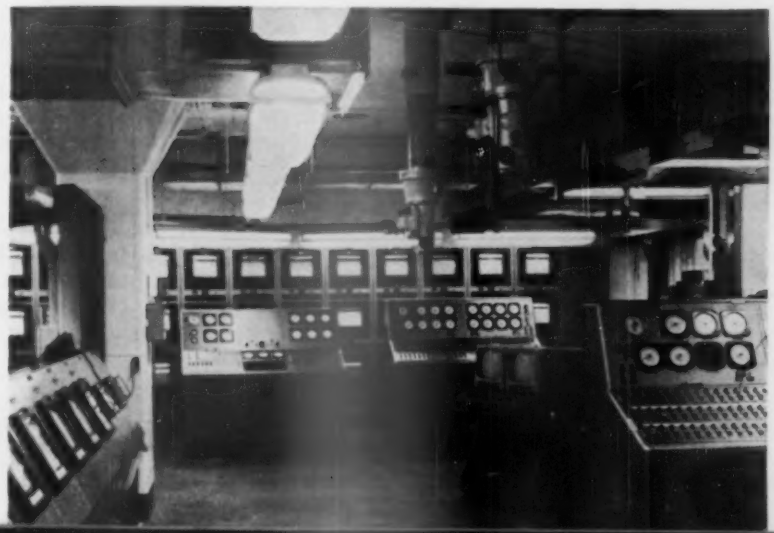
Most of the installations and the instrumentation now widely dispersed on this wild and boggy 10,000-acre site in the Cumberland Fells strictly follow U. S. practice. Modifications, where they exist, are aimed largely to effect an economy in manpower and equipment.

The site was developed with a pace and priority which surpasses that afforded any postwar British government



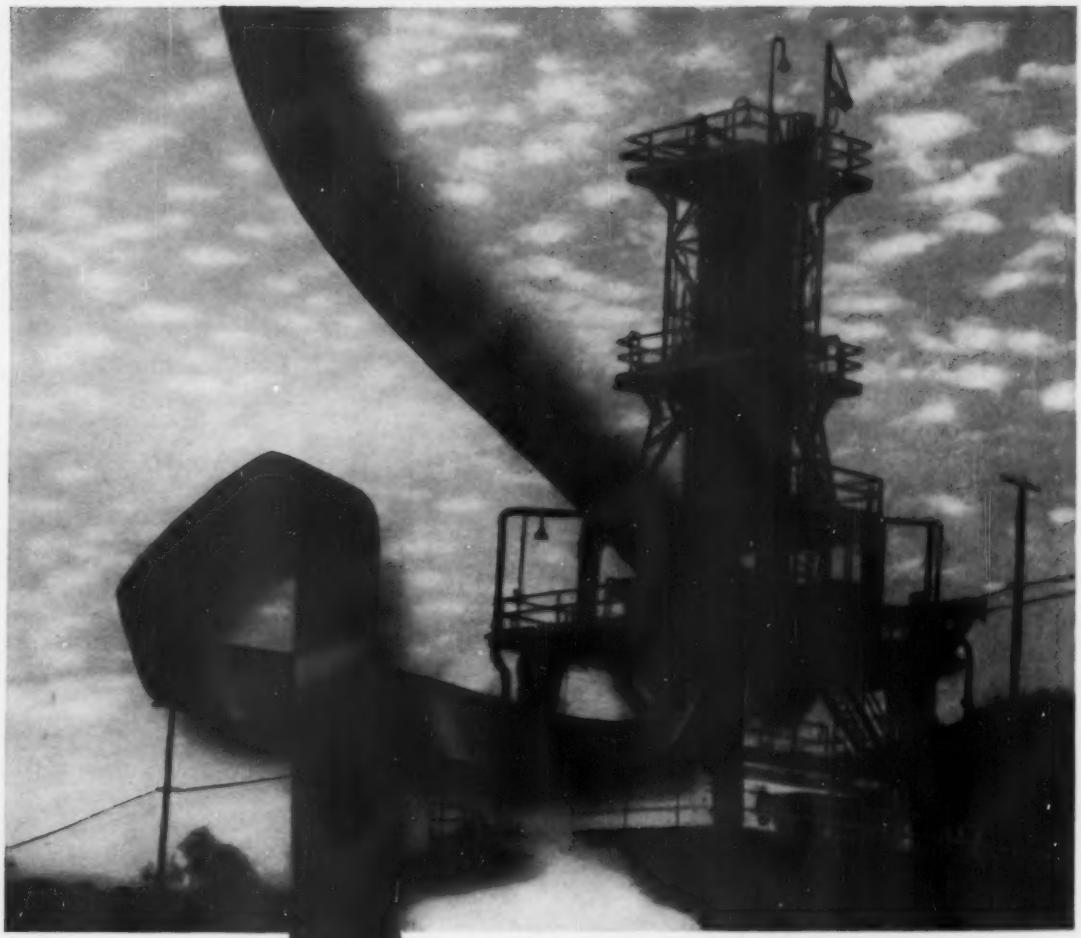
ENGINE test tower at Spadeadam is used as a temporary missile servicing facility.

COOLING pool holds 1 million gal. Below is engine control blockhouse, remotely located.



WORKING PARTNERS

ROCKETDYNE AND SOUNDCRAFT INSTRUMENTATION TAPES



At North American Aviation's Rocketdyne division, the recording of rocket engine performance on static stands, calls for the use of only the most reliable of instrumentation tapes, like Soundcraft. Why? Because Soundcraft Instrumentation Tapes combine exact physical and electrical properties so necessary to assure absolute reliability of performance—as a direct result of being manufactured in the world's most modern tape plant under the most advanced quality control system.

In short, experience has proven that Soundcraft Instrumentation Tapes *work best* in recording of critical rocket testing operations. Why not let precision-made, error-free Soundcraft Instrumentation Tapes go to work for you? Complete literature on request.

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BLUE STREAK rocket motors are shown on assembly line in engine buildup shop. Turbine is apparently an axial flow type and accepts hot gas from generator located under exhaust elbow (note engine on stand at left and below). Engine is mounted on conventional gimbal.

research or military establishment including those built to support the crash program behind the buildup of Britain's nuclear industry.

It was scheduled to cost about $62.5 million. At least $52.5 million has already been expended and all the material and equipment in the original program has been procured.

The major facilities include two missile test stands with traversing towers and equipped for static test firing, and four engine test and development towers.

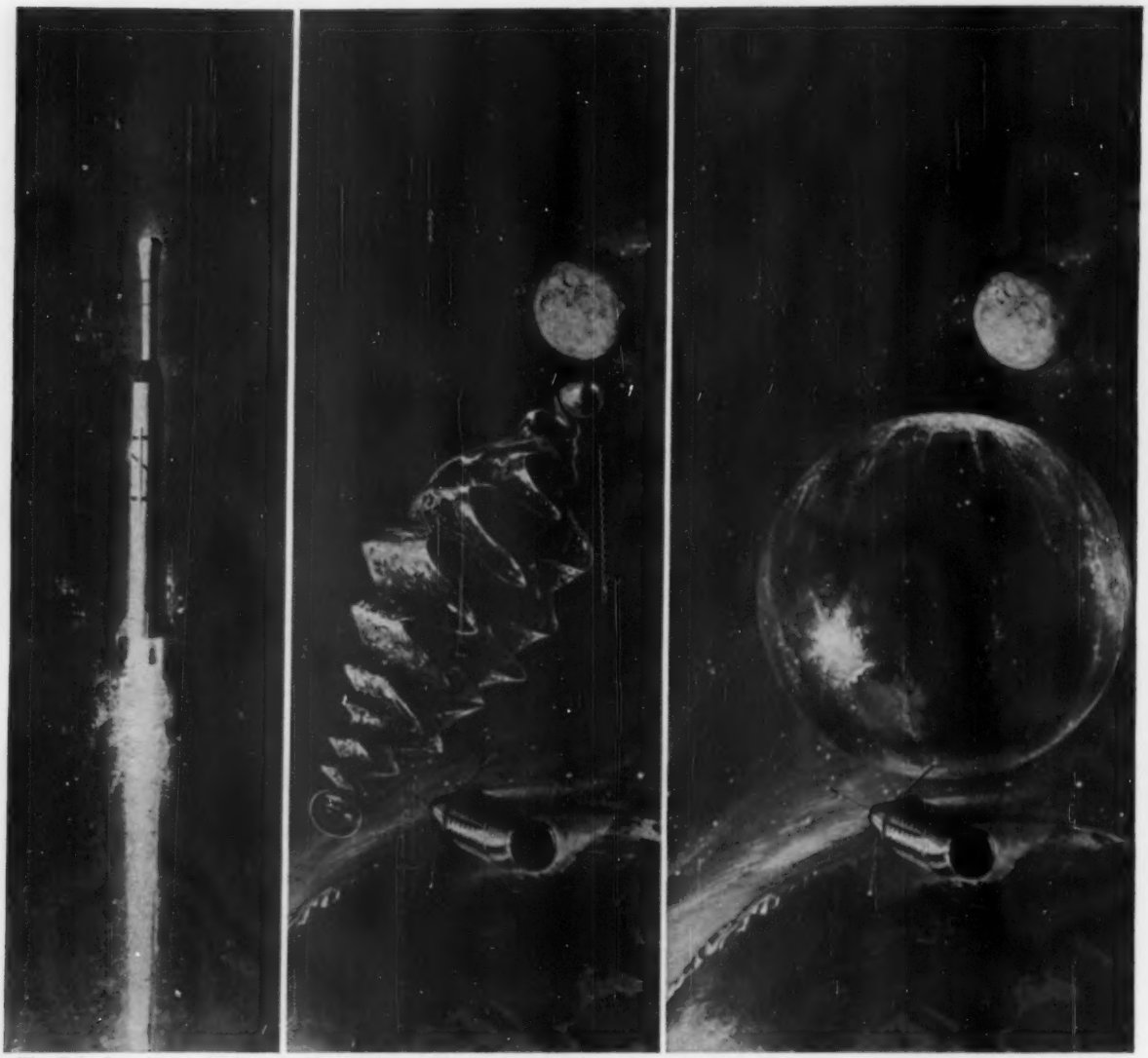
Costs Cut

One of the missile towers is complete and the other well advanced. Three of the engine towers are in service. The fourth represents a major departure from U. S. practice and involves a switch to reinforced concrete which has cut the cost to about one third that of a conventional steel tower.

In another area component testing and calibrating is carried out in nine test cells grouped around a central blockhouse from which the tests are instrumented and remotely controlled. On the same site is the largest flow calibration facility in Europe. All this equipment is in service.

Liquid oxygen from the British Oxygen Co. tonnage air distillation plant installed on the site is delivered to storage vessels in each of the three test areas. Gaseous nitrogen from the same plant is piped through a ring main at 3,500 psi.

Leading rocket engineers at Spade-



Thor-Delta launches payload toward 900-mile orbit

At altitude, satellite is released, inflates to 100-ft. diameter in two seconds

"Project Echo" satellite in orbit, ready to reflect radio signals from NASA transmitters on earth

New plastic moon lets all our scientists share in satellite tests

Your voice may "echo" around the world as a result of this cooperative Space Age project . . .

"Project Echo," National Aeronautics and Space Administration's satellite launch, comes like a "windfall" research grant to scientists.

The aluminum-coated plastic sphere went into orbit folded inside the nose of a Douglas *Thor-Delta*. Researchers have been invited to further their own experiments with the aid of radio signals bounced off the satellite by NASA transmitters. Data on the orbit and signals is being widely publicized by NASA in the belief that "cooperative tests" can result in new civilian space research advances.

Such satellites may one day be used as global relay stations for radio, voice and TV signals. While this system is not a reality, the booster that can put it up already is. Douglas *Thor* has proved itself successful in 87% of its space firings. This dependable launcher is another product of the imagination, experience and skill Douglas has gained in nearly 20 years of missile development.

DOUGLAS

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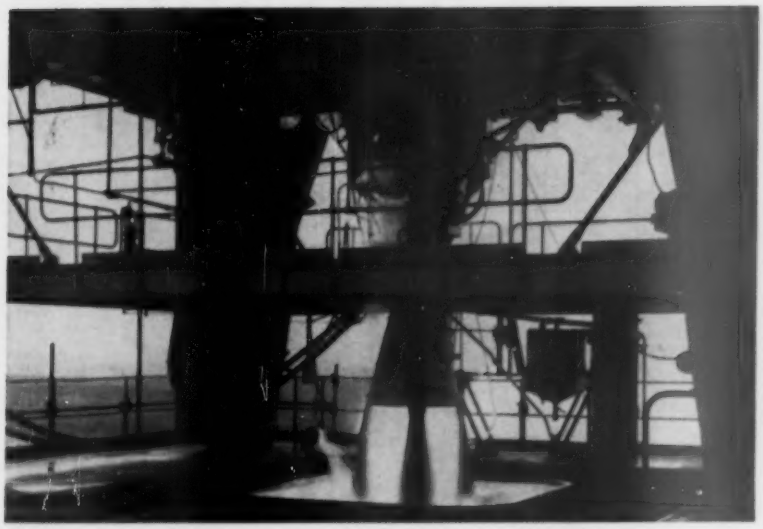

SINGLE engine development tower was designed to save on heavy instrumentation.

adam told AVIATION WEEK that the Rolls-Royce detail modifications to the Rocketdyne motor have given the British variant the edge over the S3 engine family. "It is no longer a one-way information deal," said a Rolls expert.

One of the principal differences between the two variants lies in the propellant cutoff details which in the case of the British engine have to be extremely precise as Blue Streak is not fitted with vernier rockets. This has led to the development of a new nitrogen-operated control valve with a response rate of which Rolls-Royce is "extremely pleased."

Rolls-Royce also says it has considerably improved the performance of the turbopump unit by the application of both design and fabrication details from existing company gas turbine and blower rotor systems. No details of the motor have been released but inspection of the turbo unit indicates gas flow from the generator in a vertical direction to an axial two-stage turbine. Gas temperature is of the order of 600C. The Rocketdyne rotor system configuration is, however, unchanged.

Fuel flows in a multiplicity of parallel paths along the nozzle, making one pass in each direction in adjacent ducts which form the nozzle.

The propellants are injected into the combustion chamber through an ejector disk. The oxygen is believed to enter through holes at the center of the disk and the fuel ejected through narrow concentric slots on the disk face.

The instrumentation on the rocket nozzles is gated to cut out any test firing if excitations of the nozzle due to rough combustion fall below 200 cps. Effects of frequencies up to 3 kc. have been investigated in the engine test program.

Work first began on the Spadeadam site in January, 1957, and was sufficiently advanced for the first firing of a Mk. 2 motor about a year later.

Prior to this test, engine development on a more rudimentary motor believed to be designated the RZ 1, was carried out at Westcott rocket research establishment near Farnborough.

Serial numbers on the 10 rocket motors in the motor assembly shop suggest that about 120 motors have been built.

Genie Shelf Life To Be Extended

Los Angeles—Major improvement program for the rocket motor of the Douglas MB-1 Genie is being pushed to phase a refined version of the nuclear-tipped, air-to-air unguided missile into the Air Force's tactical aircraft arm early next year.

Aerojet-General, as subcontractor under a USAF development contract to Douglas, is targeting the improvement to provide:

- **Solid-propellant rocket motor** with substantially extended shelf-life, to increase the time span for effective Genie use.
- **Low-temperature operational** capability exceeding that of a solid-propellant rocket of comparable size.

As prime contractor, Douglas also has proposed to the Air Force another improvement program leading to an advanced version of the Genie, which might extend the missile's operational use four to seven years and provide increased kill potential against targets incorporating advanced electronic countermeasures techniques and high- and low-altitude and high speed capabilities.

The proposal stems from a Douglas-funded study and provides for adaption, without major airframe modification, to Genie-carrying interceptors.

Considerably more than 7,000 Genies already have been built and delivered to the Air Force by Douglas for use on the Northrop F-89, McDonnell F-101B and Convair F-106. There is a good possibility that Genie may also be selected for arming foreign interceptor-type aircraft.

Production of the Genie probably will extend through 1961 in accordance with present procurement projections.

Navy Awards Bendix PMR Service Contract

Navy has awarded Bendix Corp.'s Radio Division a $1,600,000 contract to operate and maintain electronic equipment on Wake, Eniwetok and Midway Islands used in missile nose cone and satellite recovery and to perform other operational services in the Pacific Missile Range.

Bendix personnel will operate the Kaneohe Communication Center in Hawaii, which connects downrange stations with range headquarters at Pt. Mugu, Calif., and will be on board two Navy recovery ships, the Dalton Victory and the Haiti Victory.

The contract covers the extension of technical services which the Bendix Radio Division has been performing over the past year. The company has established a coordinating office in Honolulu.

Cook Electric Awarded ICBM Base Contract

Intersite communications systems for three Titan and Atlas ICBM complexes will be built by Cook Electric Co.'s Advanced Communications Engineering Division for USAF under a $4,765,858 contract awarded by Rome Air Materiel Area.

The company will be responsible for all phases of the communications systems, such as instrumentation, engineering construction, checkout and maintenance.

Grumman Gets Contract For Eagle Airframe

Grumman Aircraft Engineering Corp. will produce the Eagle missile airframe, propulsion system launcher and modify the testbed Douglas A3D (AW Sept. 12, p. 115) under an $8,376,034 subcontract awarded by Bendix Corp.'s Systems Division, prime contactor for the Eagle missile system.

Grumman also is developing ground-handling equipment for the Eagle long-range air-to-air system.

CASE HISTORIES

Special high-temperature, full complement N/D ball bearing, made of cobalt base alloy, operates successfully at high temperature with no need for lubricant protection!

Photo: Courtesy Stratos Division, Fairchild Engine and Airplane Corp.

Special Alloy Ball Bearings Keep Butterfly Valve Modulating at 900° F.!

CUSTOMER PROBLEM:
Require highly heat-resistant ball bearings for butterfly valve which modulates 900° F. hot air blast in turbine air bleed. Despite radial loads up to 300 lbs., shaft must turn effortlessly through 65°.

SOLUTION:
New Departure Sales Engineers, cooperating with Stratos, manufacturer of the auxiliary power turbine, recommended N/D's special aircraft ball bearing of cast cobalt base alloy for this critical application. These bearings were selected for their ability to withstand extremely high temperatures without deterioration.

Extensive testing proved that this N/D equipped modulating system, currently used on the Lockheed Hercules C-130A, military transport, operates at required standards of performance and reliability . . . and without lubrication! In addition, other New Departure ball bearings, selected for their unsurpassed reliability, are used to support the turbine main shaft which operates at 45,000 rpm.

If you're looking for bearings that operate efficiently at unusually high temperatures and speeds, contact your local N/D Sales Engineer. For additional information call or write New Departure Division, General Motors Corporation, Bristol, Connecticut.

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BALL BEARINGS
proved reliability you can build around

MOCKUP of Chance Vought escape capsule utilizes actual F8U-1 Crusader forward section modified to provide additional space needed for emplacement of ejection, stabilization and parachute recovery systems. Pictorial displays in front of pilot (right) are being provided in capsule to optimize escape and future operational flight requirements. Note sidearm controller at right. Throttle is under left hand.

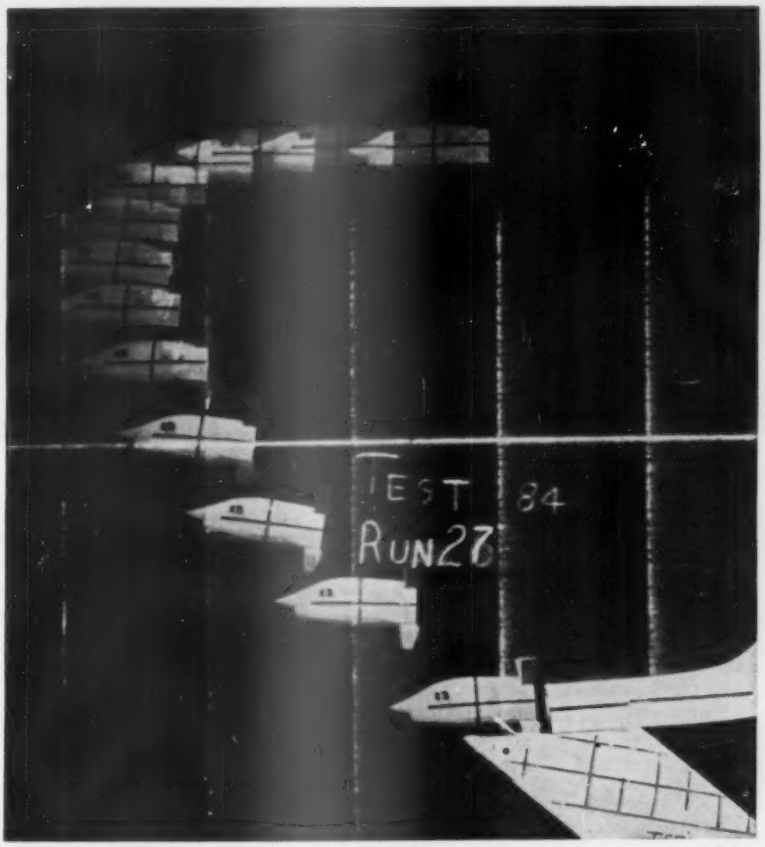
New Escape System Detaches Nose Section

By Erwin J. Bulban

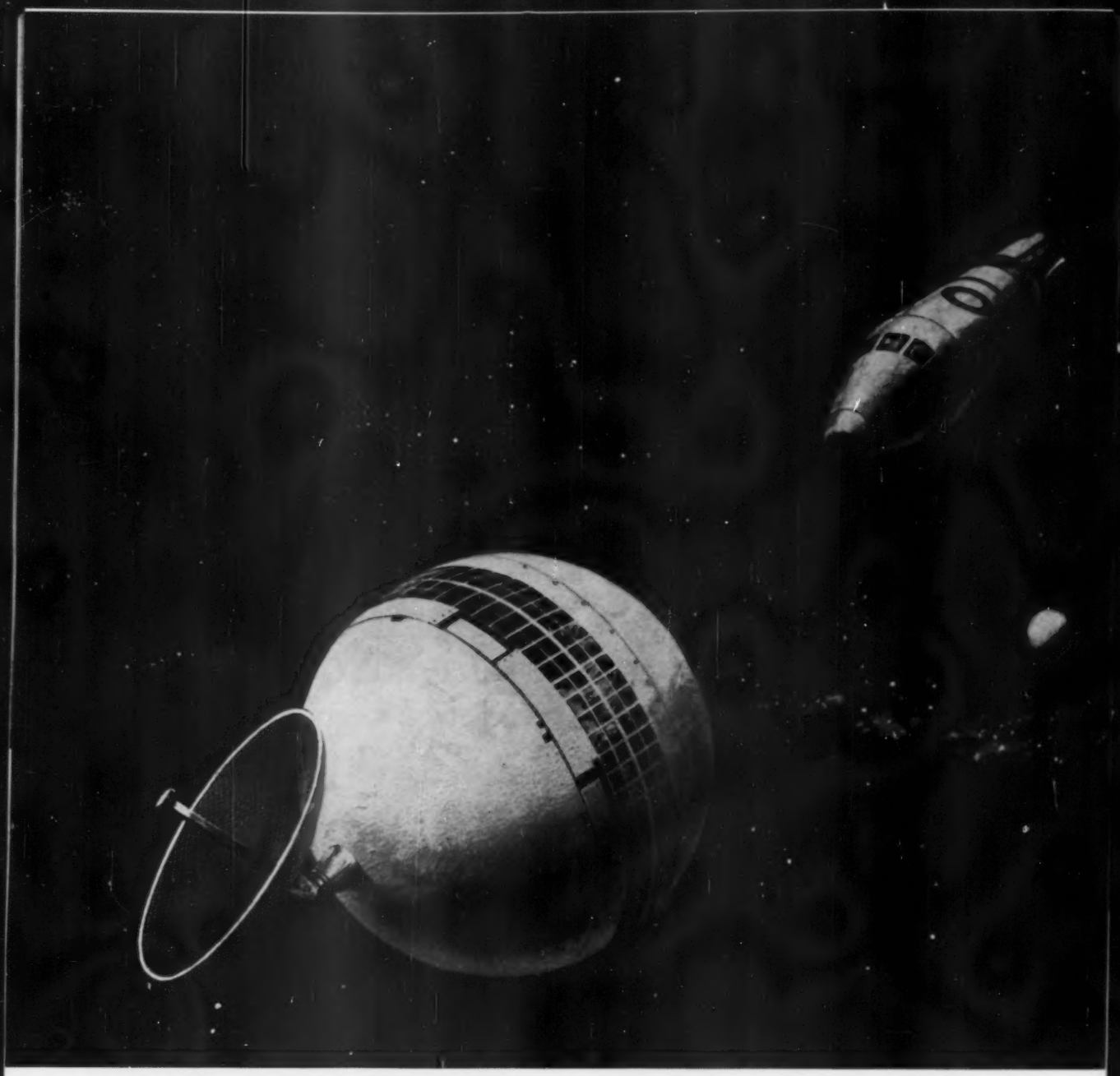
Dallas, Tex.—Improved survival characteristics in addition to bettering the combat pilot's tactical capabilities are prime goals of an integrated cockpit escape capsule development here under Navy sponsorship.

Chance Vought Aeronautics Division engineers feel that the philosophy of detaching the entire nose section of the aircraft in an emergency would make possible a lighter survival system than is possible with the seat ejection principle, since they feel that little additional structural beef-up is required to the already normal rugged construction of modern supersonic aircraft to ensure integrity of the capsule in landing. Also, retention of the pilot in the escape system, as envisaged here, makes possible greater optimization of his flight environment.

Chance Vought's escape capsule concept, developed under an initial Navy contract totaling more than $1 million, is in full-scale mockup form, utilizing an actual nose section of an F8U-1 Crusader fighter, modified to contain the separation, recovery and cockpit environment system. Inclusion of the system in a fighter of this class could be done at a cost of approximately 600 additional pounds, compared with conventional ejection systems which, with seat and pilot's personal equipment, weigh approximately 560 lb., and the newer, high-speed systems going into the next generation of operational combat air-



STABILITY study of escape capsule is shown in high-speed motion picture of model in Chance Vought low-speed wind tunnel separating at well over Mach 1. System is designed to boost capsule some 250 ft. above aircraft for maximum safe separation.



Guidance: Key to maximum Pms in space

As space technology advances, the character of space missions will become more and more sophisticated. High Pms (probability of mission success) will be increasingly dependent on precision guidance.

A major role in space guidance will be played by the gyroscope—the basic navigational reference for things inertial—and by such related technologies as space-astronautic digital computing, TV-inertial platform systems, miniature celestial inertial systems, IR sensing, and radiation resistant devices. In all of these, and in associated systems analyses such as evaluation of Pms and of overall system dynamic stability, Sperry is actively engaged.

With its unparalleled background in guidance and control over five decades, Sperry is today laying the groundwork in research, and in practical experience, for the sophisticated guidance requirements of tomorrow. Now in design or development stages are soft lunar landing and interplanetary guidance systems and controls . . . boost, mid-course, re-entry and terminal guidance . . . self-adaptive flight controllers . . . space acquisition radar systems and rendezvous controls.

These contributions to "maximum Pms" in space exemplify Sperry's overall scientific capabilities—capabilities that reach into every stratum of our environment today . . . and far into the future. General offices: Great Neck, N. Y.

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craft, which weigh some 665 lb., Chance Vought engineers say.

They are aiming at design refinements which they believe would bring the entire weight of a fighter escape capsule to approximately 2,000 lb., including the aircraft structure in this section.

System is designed to provide "shirtsleeve" environment for the pilot during the entire flight mission, including separation from the aircraft in emergencies, from maximum operational altitudes to below sea level, if necessary, the latter case taking account of crash into the water during carrier landing and takeoffs.

Supinating Seat

One of the key features in providing this environment is a supinating seat, which adjusts automatically depending upon maneuver forces initiated by the pilot. The supinating seat, hinged at a single point at the seat back and pneumatically operated, would be tied into the accelerometer. Range of movement currently considered is from 13-deg. normal attitude to complete supination of 65 deg., with the pilot retaining constant head position relative to his panel display. System, designed to rid the pilot of the need for wearing conventional pressure-type g-suits, will permit pilot to make much tighter turns and sharper pullouts than now possible, Aeronautics Division project engineers say. How much more g-capability the seat provides over g-suits is difficult to ascertain, since it depends as much on individual tolerances—but they feel the increase will be considerable.

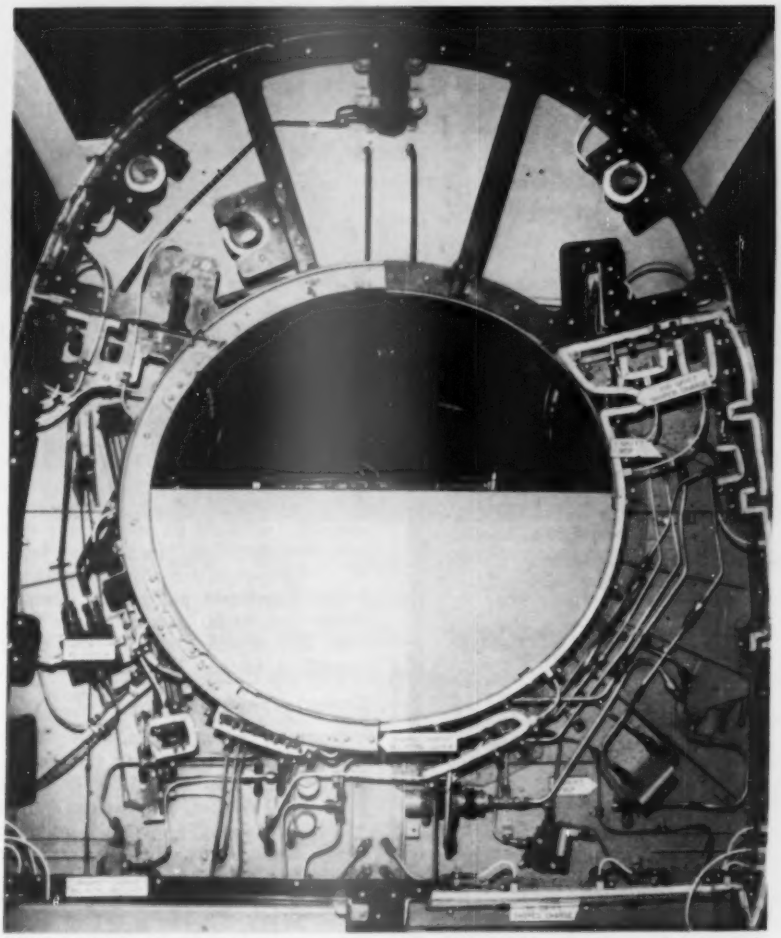
Escape provision is handled by a belt of specially designed shaped charges adjacent to the aircraft structure and systems, which when electrically actuated cuts the forward cockpit portion of the aircraft free from the remainder of the structure. The system has been tested successfully by Navy, according to Chance Vought, using actual Crusader fuselages, anchored 10 ft. underwater, at the Naval Weapons Laboratory, Dahlgren, Va.

Instrumented Tests

To test possible effects that explosive charge detonations underwater might have on an occupant of the capsule, the cockpit was instrumented. Tests indicated that despite the fact that heavier-than-usual charges were employed to exaggerate the detonation effects, they would have no adverse results on an occupant.

Several separation methods are employed to provide controlled and automatic ejection of the capsule to cover regime from high altitude to underwater. Normal separation would be activated by the pilot raising one or both forward portions of cockpit arm-

COMPLETED scale model of Vought-Navy escape capsule was supplied to National Aeronautics and Space Administration for trajectory analysis.



SHAPED CHARGE separation system developed at Chance Vought for breaking capsule cleanly from remainder of aircraft is shown above. Electrical initiation of charges was chosen for maximum reliability; system is designed fail-safe.

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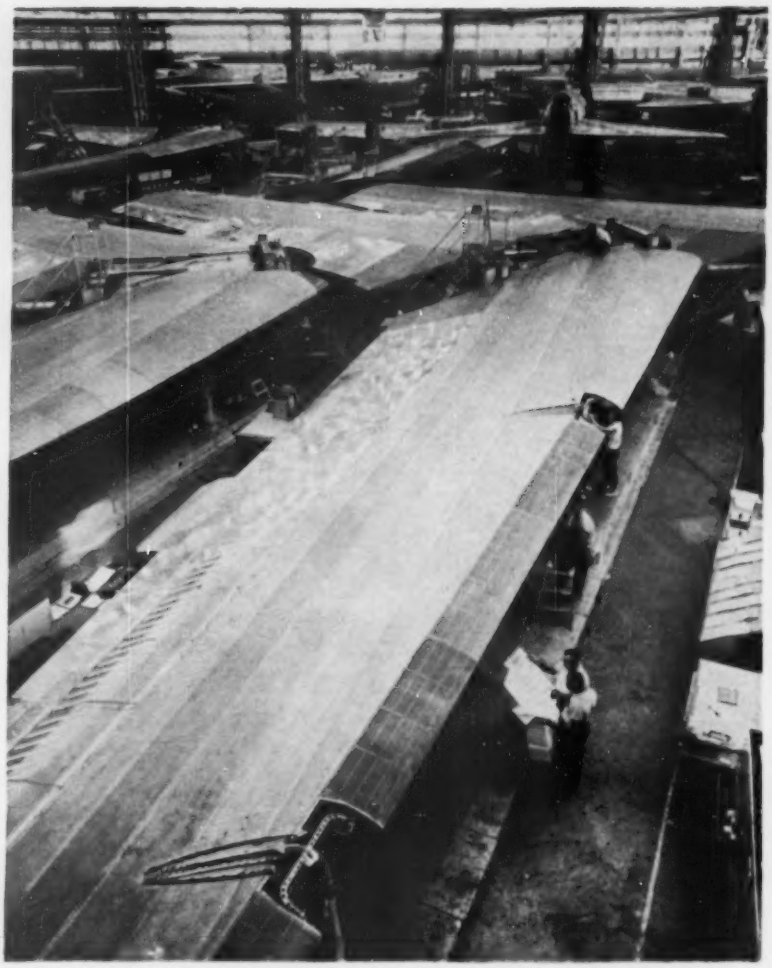


Wings Assembled for First Boeing B-52H

Wing assembly for the first Boeing B-52H missile bomber nears completion at the company's Wichita, Kan., Division plant. The 185-ft. wing will carry both fuel and Strategic Air Command's new Skybolt air-launched ballistic missiles.

rests. Shaped charges then cut the capsule free immediately of the aircraft. Four stabilizing fins are electro-pneumatically actuated to prevent the capsule from tumbling. Fins have a built-in 10-deg. up cant to overcome an inherent five-degree pitch-down moment of the capsule on separation. In addition, line of action of the drag chute imparts a further 20-25-deg. pitch-up.

Capsule Separation

Boosting the capsule positively from the separated remainder of the aircraft would be done by two 15,000-lb.-thrust solid rocket motors, with nozzles canted 45-deg. downward. A Naval Ordnance Test Station study, this rocket motor would employ a single wagonwheel six-spoke grain of 7.5-in. diameter and 28-in. length. Over-all length of rocket motors would be 38 in., diameter 8 in., and weight 100 lb.

First-stage parachute would deploy at or below approximately 60,000 ft. to slow the capsule. At approximately 15,000 ft., the recovery chute system, comprising three canopies, would open. Capsule would also utilize air-filled bags, collapsible on impact, to take landing shocks. System is designed to provide pilot with ability to reduce hazards of exposure by remaining in the capsule until pickup.

Should an emergency occur during takeoff or landing, the separation sequence skips deployment of the drag chute, reducing time to deploy main recovery chutes. In event of pilot being incapacitated, an automatic, dead-man's switch-type mechanism is employed. Pilot might employ this in combat situations. System is activated, but control is retained by pilot's hand pressure on the side-arm controller. Should he release his pressure, the separation and recovery sequence starts in three seconds, although he can halt initiation at

any time within this period by again squeezing the controller.

Survival in event of a crash into water during carrier landing or takeoff would be provided by a water-sensitive switch which activates the separation system.

Final phases of the company's initial development contract entail firing of three-foot models of the integrated capsule at subsonic and supersonic speeds at National Aeronautics and Space Administration's Wallops Island, Va., station later this year. Models will be rocket-propelled and telemetering equipment will provide data on stability and acceleration forces on the models.

Proposed program for follow-up development includes:

• **Detailed engineering** of the capsule, also a pilot environmental test series, which would be handled at Navy facilities. A life-support system to provide necessary oxygen concentration and cockpit pressurization, obviating need for personal oxygen mask or pressure suit, would be manufactured and evaluated in the low-pressure chamber at Navy's Air Crew Equipment Laboratory, Philadelphia, Pa.

• **Pilot restraint systems** would be tested at the vertical and horizontal acceleration facilities at ACEL. The supinating seat would be tested at the Aeronautical Medical Acceleration Laboratory, Johnsville, Pa.

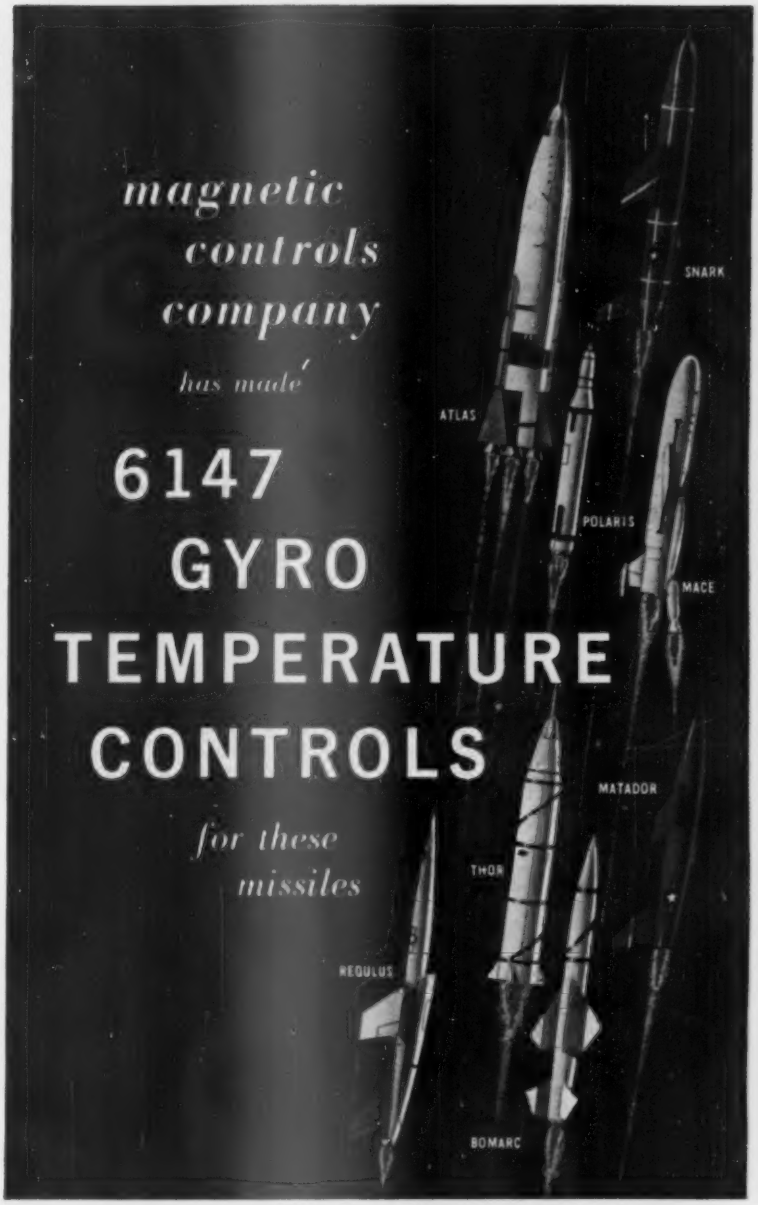
• **Rocket sled tests** would be made to study separations of the capsule from the afterbody, flight stabilization and the parachute recovery systems to simulate speeds from takeoff to supersonic.

• **Final phase of the program** would entail three actual full-scale in-flight separations from an F8U aircraft, two of which would utilize drone Crusaders fitted with dummy pilots and a final test using a live subject.

PRODUCTION BRIEFING

F-48, a columbium (niobium) alloy, is one of the newer materials being welded and machined by Ling-Temco Electronics, Inc., Dallas, as part of its work in the USAF Refractory Metals Structural Development Program. Basic program involves fabrication and testing of structural components such as boxes or cylinders, and their testing under simulated re-entry environment. Columbium offers promise because of its ability to retain usable structural properties up to 2,500F. Early test specimens made by Ling-Temco included parts of Fansteel 82, a columbium-base alloy containing tantalum and zirconium, which was formed, spot- and fusion-welded into assemblies.

Quality increase, weight reduction and uniformity of production parts have been dividends of Aerojet-General



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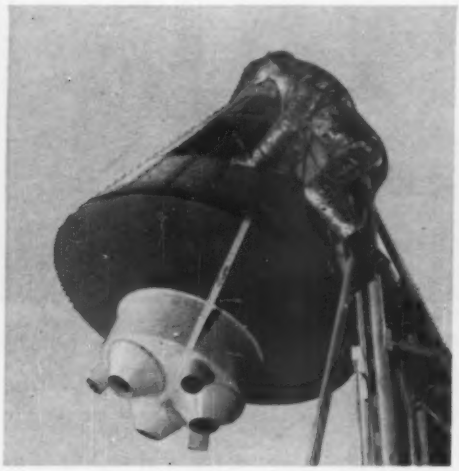
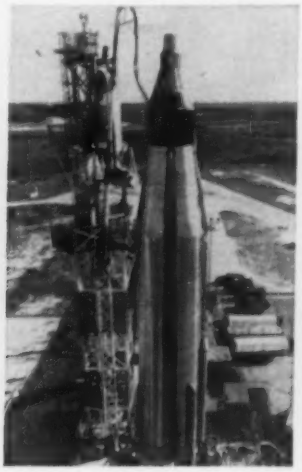


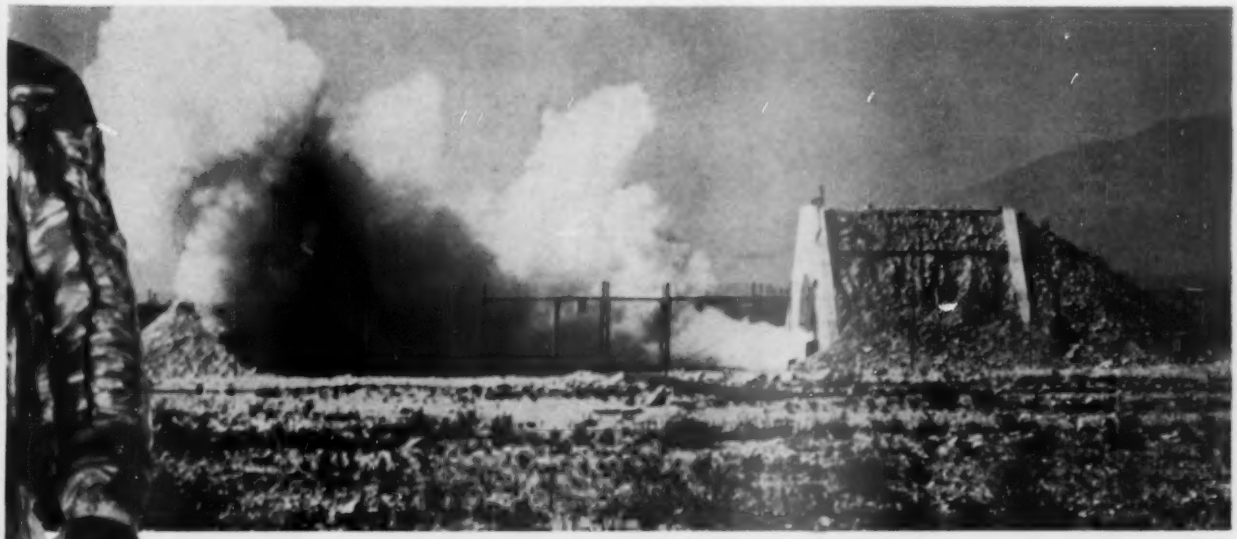
Mock-up of Project Mercury capsule, built by McDonnell Aircraft Corporation for the manned orbital flight program of the National Aeronautics and Space Administration.



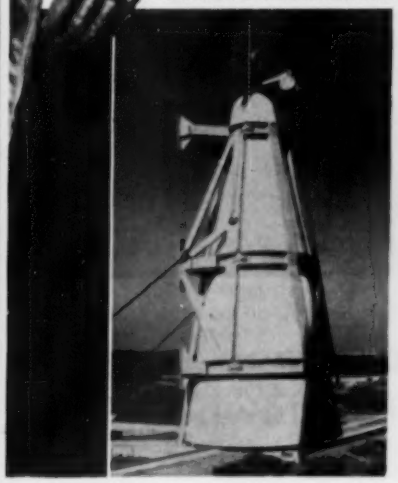
In "Big Joe" test launching, full scale model of Mercury space capsule was boosted 100 miles high atop this Air Force Atlas missile. Capsule was protected by a B. F. Goodrich laminated glass fibre and resin heat shield fabricated under subcontract to General Electric.

SUITING UP THE ASTRONAUTS The pressure suits to be worn by the Astronauts are now being fitted by B. F. Goodrich. This suit must maintain enough pressure to keep a man's blood from boiling, must provide air to breathe, must protect against searing heat. In the bargain, this pressure suit is light weight and flexible enough to allow free movement.

HIGH ENERGY SOLID PROPELLANTS This static test stand is one of 56 specialized facilities at the B.F.Goodrich solid propellant plant...currently processing and loading solid fueled motors of the LOKI, RTV and ASP types. BFG pioneered the development of the major polymeric binder-fuels now being used in the most advanced missiles.

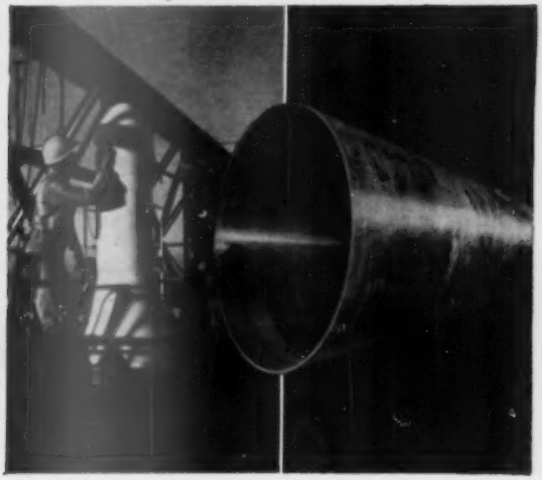


B.F.GOODRICH ABLATION SHIELDS ARE USED ON THESE U.S. AIR FORCE/GENERAL ELECTRIC SPACE VEHICLES



RVX-2 Re-entry/Recovery Vehicle, the largest ablation-type re-entry vehicle to travel full ICBM-range and be recovered.

Satellite Aeromedical Re-entry/ Recovery Vehicle for USAF Discoverer Program.



Mark-3, an advanced operational-type re-entry vehicle for the Air Force Atlas.

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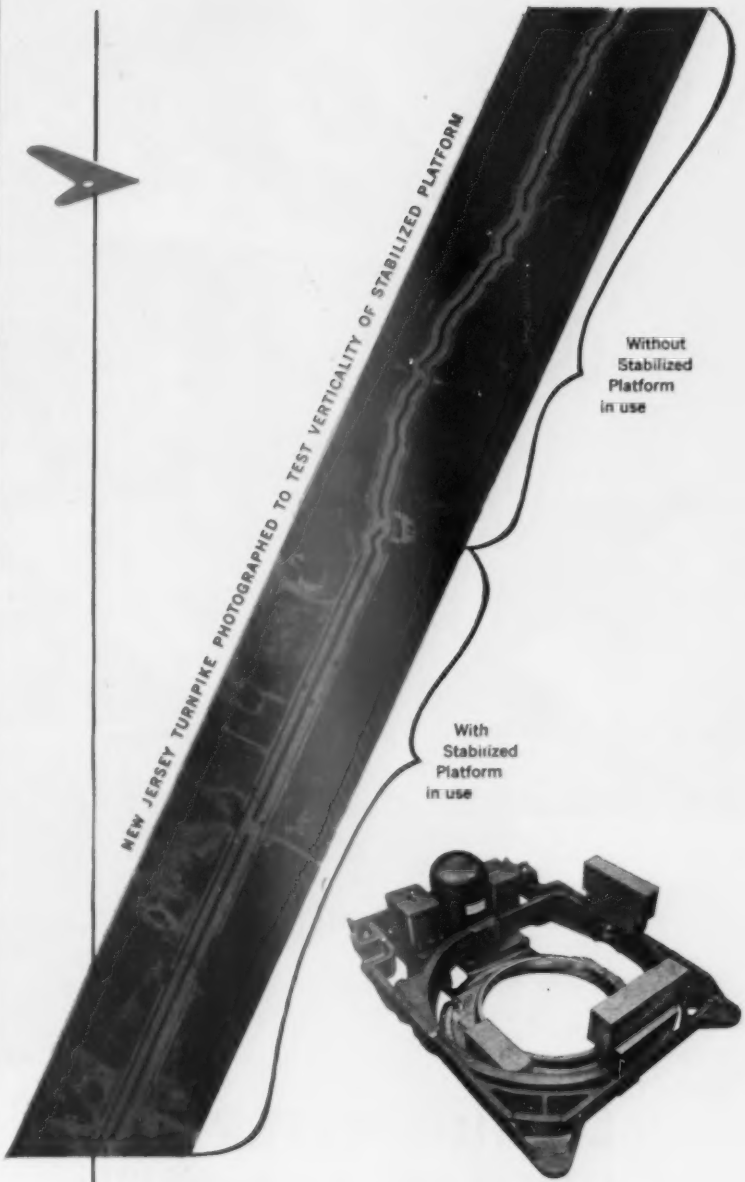
Corp.'s switch to numerical control for fabrication of Polaris first- and second-stage hardware. Ability to maintain wall thickness to plus or minus two thousandths saved eight to 10 lb. per part, the company said, and fabrication time was cut by two-thirds. Cumulative errors caused by either template or model checking techniques were eliminated by Aerojet's switch. Production lead time was reduced and design changes could be fed in more rapidly with numerical control. Looking to the future, Aerojet says that costs are competitive with former low-cost production techniques; that numerical control will be used on other Polaris manufacturing processes, and that parts from several vendors using numerical control should be identical.

Stratos Division of Fairchild Engine and Airplane Corp., Bay Shore, L. I., N. Y., has received a $280,675 contract for units to supply cool air to ready-status aircraft on the flight deck of the USS Enterprise, nuclear-powered aircraft carrier. Units will deliver 50 lb. per minute of cooled air at a discharge temperature variable from 35F to 70F. Integral water separator is part of the unit. Design life is 10,000 hr. between overhauls and 2,000 hr. without oil change.

Twin Coach Company engineers are studying aircraft and missile applications of a new technique for forming corrugated sheet now being used to fabricate office partitions. Company developed a machine using coil stock, self-fed through forming dies which fold the metal into corrugated shapes. Machine can handle conventional materials used in aircraft applications in stock sizes up to 36-in. width. Wider stock would require a larger machine. Company says set-up time is short, labor costs for loading and operating are small, and dies have about a 1,000-hr. life. Current runs are being made in metal gages running from 0.002 to 0.030 in., with tolerances of plus or minus one thousandth.

Sylvania Electric Products' Waltham Laboratories has a $2.4 million contract for development, fabrication and installation of two 60-ft. ground antenna systems for U.S. Army Signal Corps' portion of the Advanced Research Projects Agency ADVENT satellite communications program. Project ADVENT embraces research leading to a world-wide communications network that will operate through utilization of "stationary" satellites. By orbiting some 22,000 mi. above the equator in the same direction and at the same speed as the earth's rotation, each satellite woud appear to hover over a single ground point.


NEW JERSEY TURNPIKE PHOTOGRAPHED TO TEST VERTICALITY OF STABILIZED PLATFORM
Without Stabilized Platform in use
With Stabilized Platform in use

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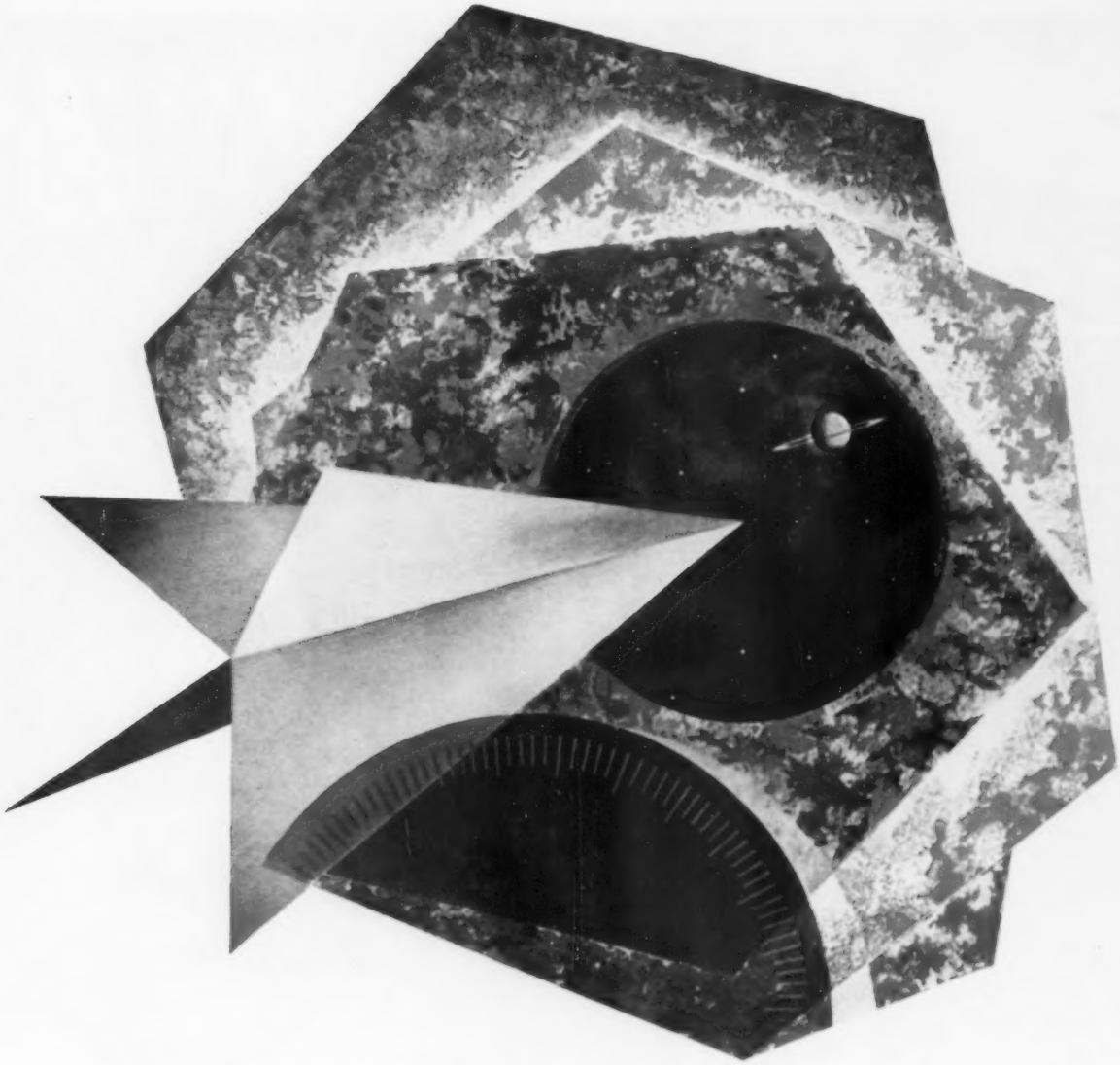

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. . . offers the dependability of long experience in both electronic and electromechanical instrument control systems, plus the versatility of original design.
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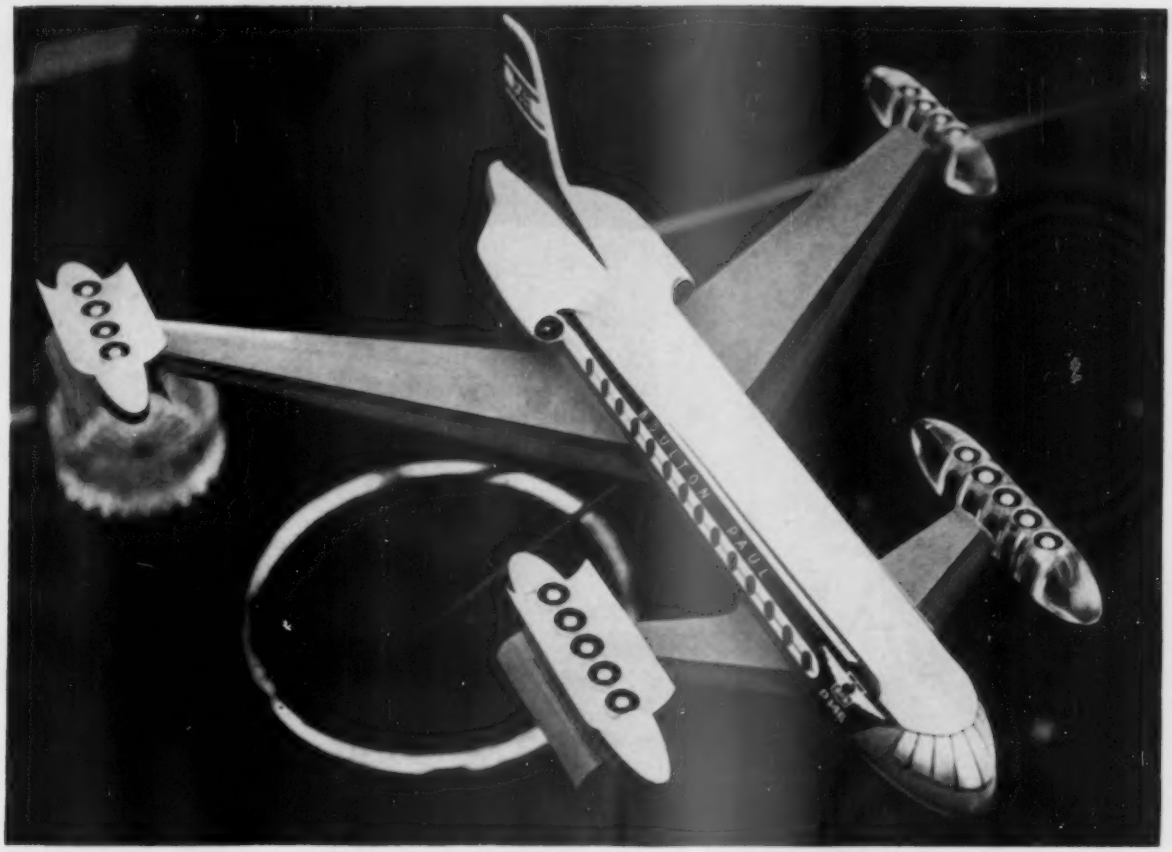
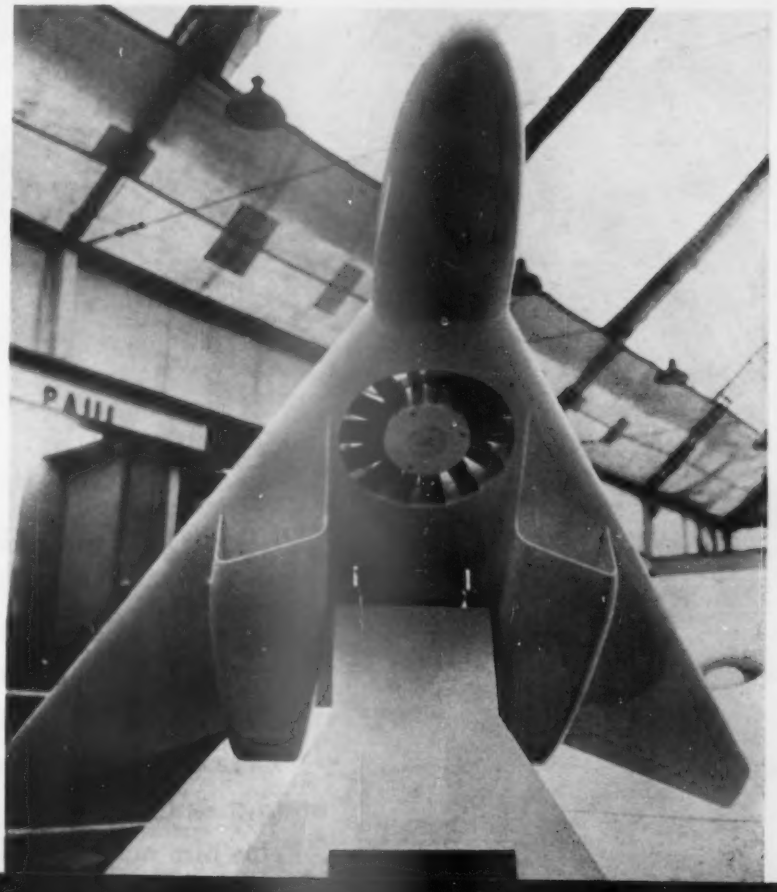


Boulton Paul Aircraft's concept of a VTOL transport, the P.146, is shown at Farnborough in model form.

Boulton Paul Unveils VTOL Configuration

Model on display at 21st Society of British Aircraft Constructors exhibit at Farnborough shows VTOL transport configuration proposed by Boulton Paul Aircraft, Ltd. Designated the P.146, the study envisions use of a total of 18 ducted fan engines housed in four pods for vertical lift plus three turbojets—one in the tail, the other two podded around it—for forward flight after transition. Two pods, each containing five small ducted fan engines, are swung from stubbed pylons jutting from either side of the nose. Remaining two pylons, each with four ducted fans, are located on tips of the swept wings. Boulton Paul Farnborough display also included VTOL wind tunnel model (right) with a single lift fan engine buried in its fuselage section and two turbojet engines beneath the wings for forward flight.



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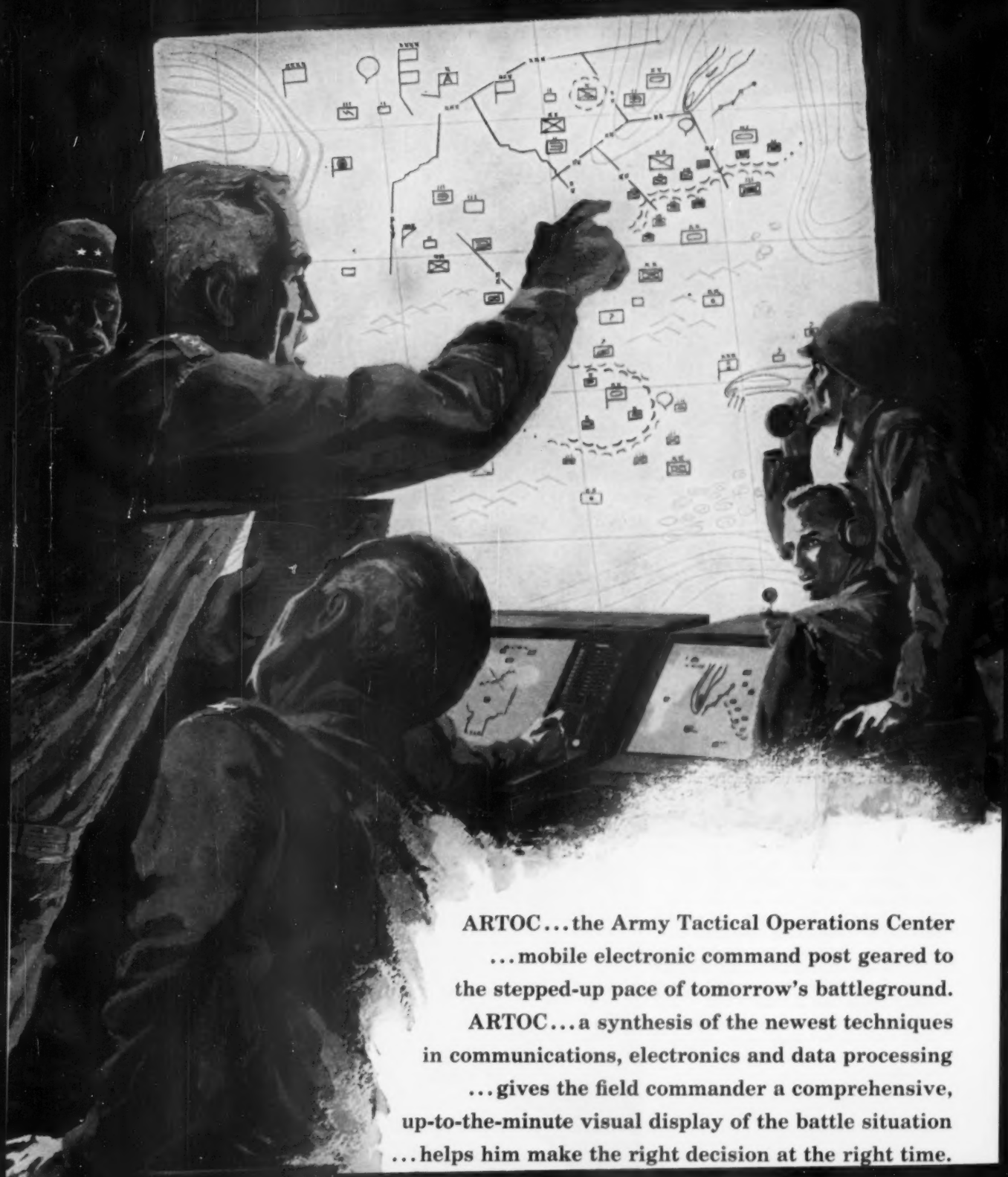

ARTOC...the Army Tactical Operations Center ...mobile electronic command post geared to the stepped-up pace of tomorrow's battleground. ARTOC...a synthesis of the newest techniques in communications, electronics and data processing ...gives the field commander a comprehensive, up-to-the-minute visual display of the battle situation ...helps him make the right decision at the right time.

ARTOC... is being developed by Aeronutronic Division of Ford Motor Company for the U.S. Army Signal Corps. It is one of many Aeronutronic programs aimed at simplifying military and industrial problems through the use of an advanced computer and data processing technology. These programs—and many others related to advanced weapon and space systems—are underway at Aeronutronic's Engineering and Research Center in Newport Beach, California. They demonstrate Ford Motor Company's rapidly-growing capability in meeting the needs of science and defense in the changing world.

A booklet describing Aeronutronic's accomplishments and capabilities is available to you on request.

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AERONUTRONIC DIVISION *Ford Motor Company*, DEFENSE PRODUCTS GROUP

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WEAPON AND SPACE SYSTEMS • COMPUTERS AND DATA PROCESSING SYSTEMS
MISSILE RANGE SYSTEMS AND INSTRUMENTATION • ADVANCED ELECTRONICS
Career opportunities are open for engineers and scientists

WHAT'S NEW

Reports Available

The following reports were sponsored by the Office of Technical Services, United States Department of Commerce, Washington 25, D. C.

Materials Research in the Navy—Office of Naval Research. March, 1959. Vol. I. $6.00; 386 pp. (PB 161470) Vol. II. $5.00; 378 pp. (PB 161471)

Radiation Chemistry and Related Phenomena—1st Lt. G. G. Wepfer, USAF, and others, Wright Air Development Center, Materials Laboratory. Parts I, II & III. November, 1959. $2.25; 91 pp. (PB 161414)

Investigation of Liquid Nitric Oxide as a Rocket Oxidizer—L. E. Bollinger & R. Edse, Ohio State University Research Foundation. May, 1959. $.75; 29 pp. (PB 161300)

Appendix to Civil Aeronautics Manual 3—$1.00; 204 pp. Order from: Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Publications Received:

Dictionary of Automatic Control—Robert J. Bibbero—Reinhold Publishing Corp., 430 Park Avenue, New York 22, N. Y. $6.00; 282 pp. Covers basic concepts and control theory. A classified index contains a subject breakdown.

Stabilization of Free Radicals at Low Temperatures—U. S. Dept. of Commerce, National Bureau of Standards, Washington 25, D. C. $1.50; 110 pp. Review of a three-year program in free radicals research initiated at the Bureau in 1956 and terminated on Oct. 1, 1959.

An Introduction to the Theory of Aircraft Structures—D. Williams—St. Martin's Press, Inc., 175 Fifth Avenue, New York 10, N. Y. $15.00; 448 pp. Aimed at serving as a background for the solution of aircraft structural problems.

On Wings of Faith—Violeta Constantine Kokenes—Random House, 457 Madison Avenue, New York 22, N. Y. $3.95; 244 pp. The story of the first family to fly down the eastern coast of South America and back to the U. S. via the western coast in a single engine plane.

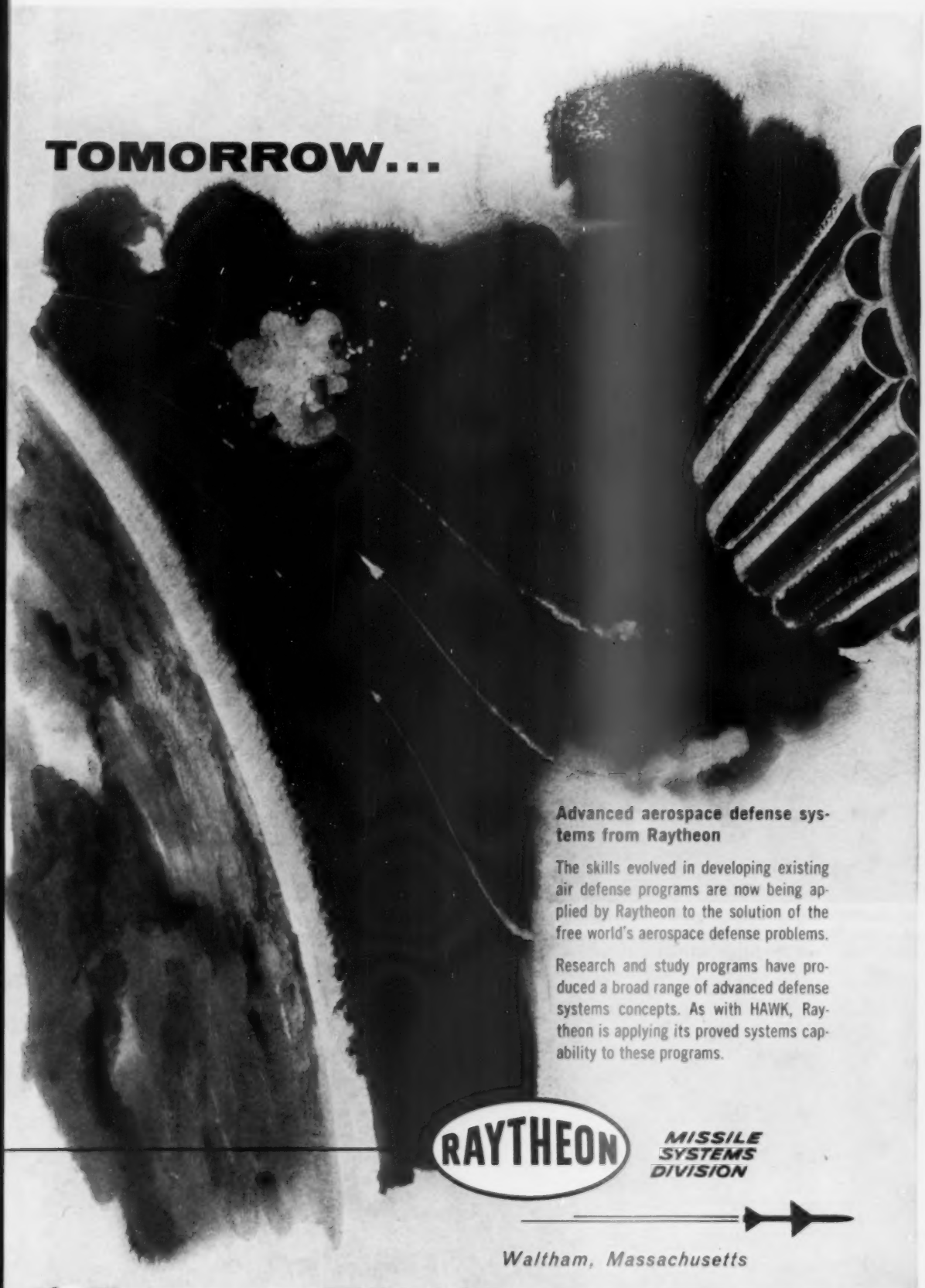
Video Tape Recording—Julian Bernstein—John F. Rider Publisher, Inc., 116 W. 14th Street, N. Y., N. Y.—$8.95; 272 pp. A fundamental treatment of the techniques, mechanics and the circuitry which are used.

...helps him make the right decision at the right time.

HAWK makes first missile-to-missile kill

Raytheon HAWK, designed for defense against low flying aircraft, achieved the first known kill of one missile by another on Jan. 29, 1960 at White Sands, New Mexico. Most recently, HAWK achieved another sensational first by blasting out of the sky a much smaller supersonic missile.

The proved achievements of this HAWK weapons system for defense demonstrate Raytheon's complete systems capability.



Advanced aerospace defense systems from Raytheon

The skills evolved in developing existing air defense programs are now being applied by Raytheon to the solution of the free world's aerospace defense problems.

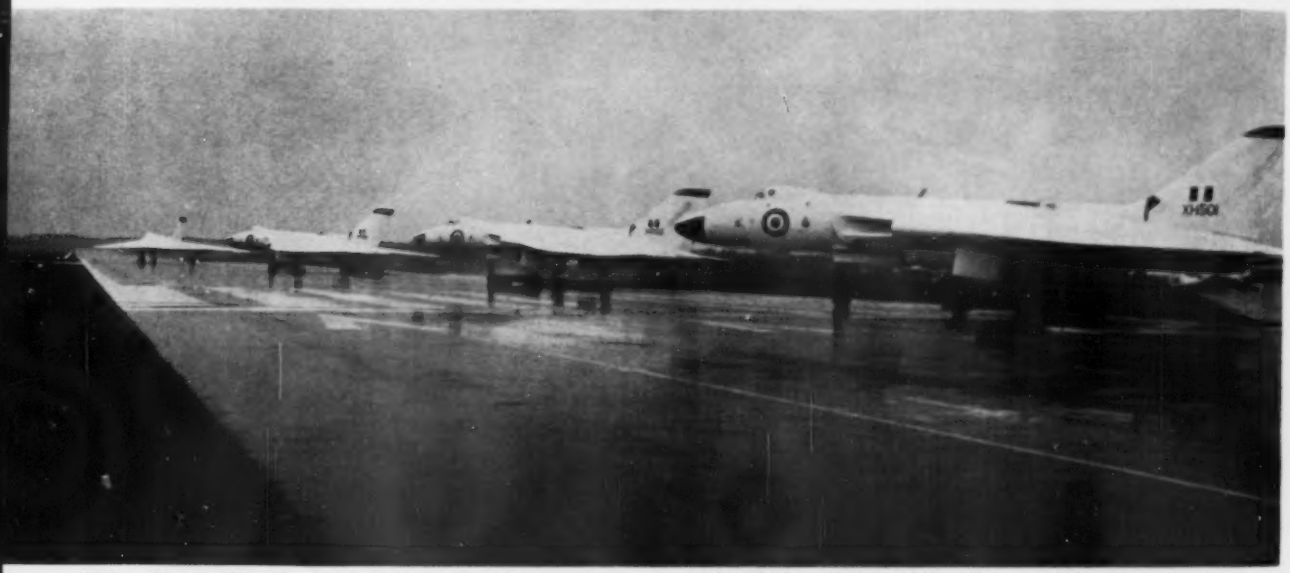
Research and study programs have produced a broad range of advanced defense systems concepts. As with HAWK, Raytheon is applying its proved systems capability to these programs.

RAYTHEON

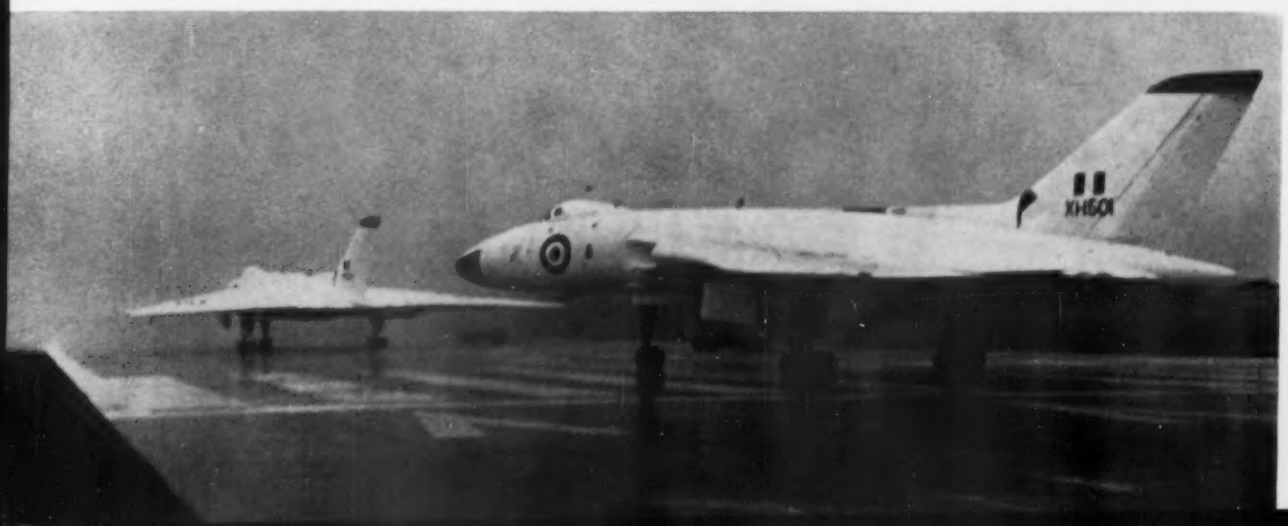
MISSILE SYSTEMS DIVISION

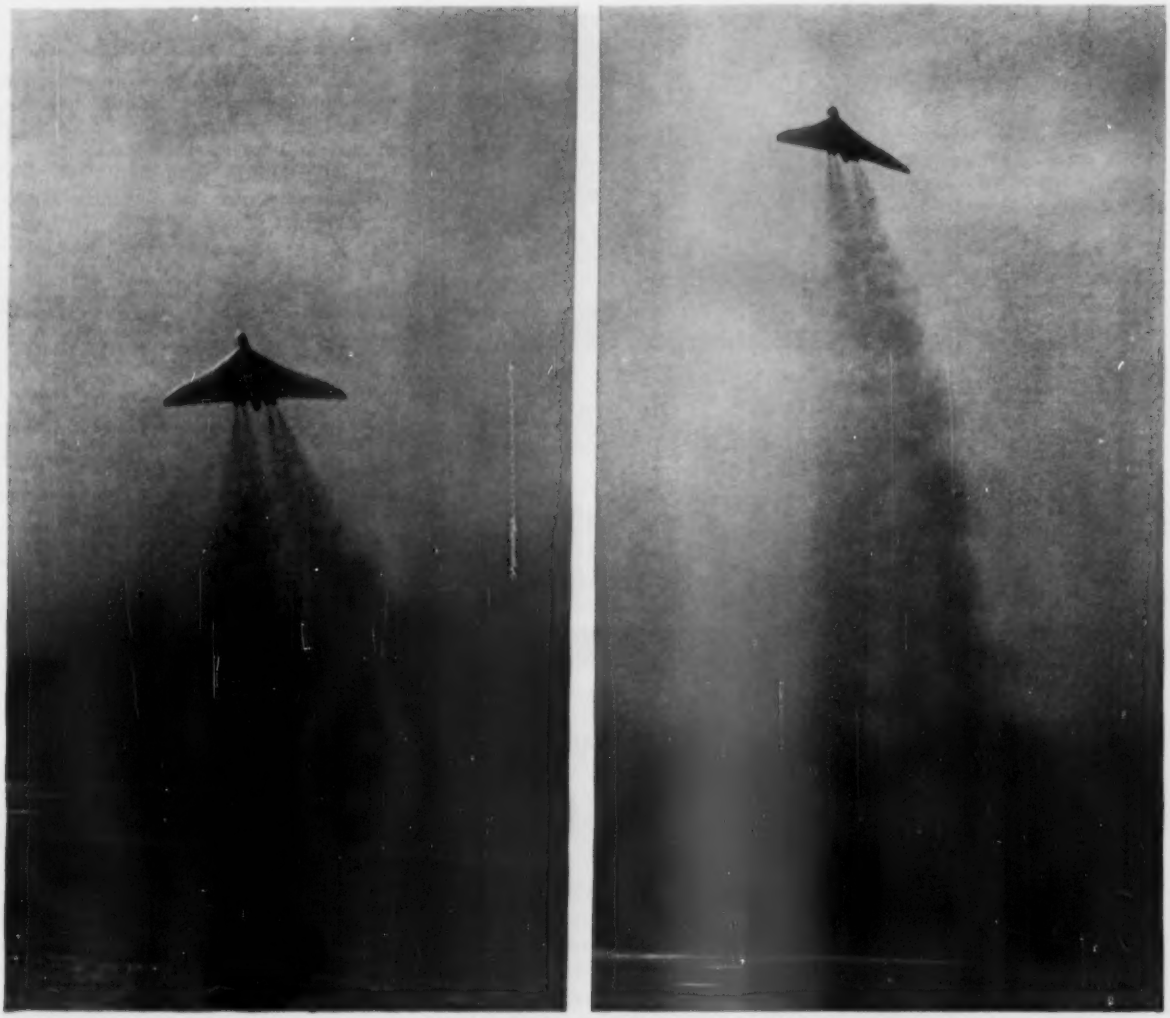
Waltham, Massachusetts

Air and ground crews of 61 Squadron of Royal Air Force's Bomber Command demonstrated a scramble of four Avro Vulcan B. Mk. 2 strategic bombers on the second day of Farnborough. Scrambles of Britain's other two V-bomber types—the Handley Page Victor and Vickers Valiant—were conducted on other days. As scramble begins in rain (above) aircraft have been flown to a simulated dispersal site after receiving intelligence reports of an impending attack, and the aircrews are at their stations inside the planes.



When the scramble order is received, a ground starter system ignites all four Vulcan Bristol Siddeley Olympus 201 engines simultaneously, and, within 30 sec., the lead aircraft is beginning its takeoff roll as the second plane moves into position. Last two aircraft swing into position (below) and prepare for takeoff.

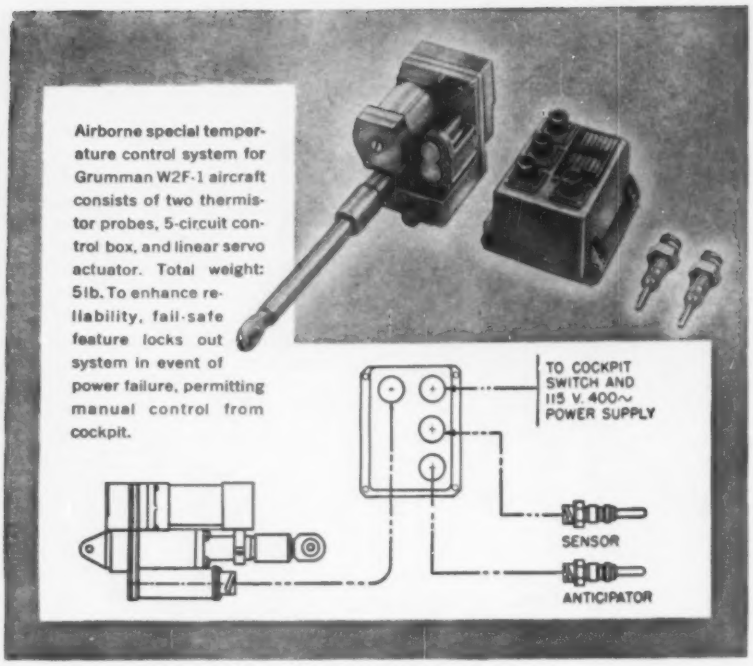




With afterburners lit, Vulcan leaves runway and begins an almost vertical ascent (left). Afterburners still on, Olympus engines send out black smoke trails (right) as Vulcan continues almost vertical climb to altitude.

RAF Crews Scramble Four Vulcans at Farnborough

Delta-wing Vulcan, its speed brakes extended, makes high-angle-of- attack touchdown onto Farnborough's rain-swept runway.


Airborne special temperature control system for Grumman W2F-1 aircraft consists of two thermistor probes, 5-circuit control box, and linear servo actuator. Total weight: 5lb. To enhance reliability, fail-safe feature locks out system in event of power failure, permitting manual control from cockpit.
TO COCKPIT SWITCH AND 115 V. 400~ POWER SUPPLY
SENSOR
ANTICIPATOR

Airborne special control system holds engine oil temperature to ±3° F

The Grumman W2F-1 airborne-early-warning aircraft, because it is operational over a wide range of environments and altitudes, imposes a severe problem in control of engine lube oil temperature. For efficient engine operation, oil temperature must be maintained within ±3°F at the air/oil heat exchanger. This, in spite of the considerable (10-100 sec.) time lag in the exchanger and in spite of the non-linear characteristics of the heat exchanger with ram air valve position.

To solve these problems, Airborne developed an electromechanical system utilizing two thermistor probes. An "anticipator" probe at the exchanger inlet senses temperature variations in oil coming from the engine, initiating a command to the actuator to correct the ram air valve setting. A "sensor" probe at the exchanger outlet monitors steady state temperature, comparing it with a specific temperature reference in the control box. Deviations from predetermined limits result in further correction by the actuator.

If you have electromechanical systems requirements – for aircraft, missiles or ground support equipment – we will be happy to make a proposal. Often we can meet requirements with an Airborne standard or modular system. If not, we are fully qualified to develop custom designs, as in this instance. New Catalog GC-60 gives further information. Contact any of our offices.

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NASA Contracts

The National Aeronautics and Space Administration awarded the following contracts, totaling more than $134 million, during the period Jan. 1, 1960, through June 30, 1960. The figures shown represent the estimated total cost of the contract.

NASA HEADQUARTERS, Washington, D. C.

Regents of the University of Michigan Ann Arbor, Mich.—$50,000—Research on the measurements of atmospheric pressure in the region between the earth and moon.

University of Chicago Chicago, Ill.—$38,525—Evaluation of telemetry records received from Explorer VI.

Chance Vought Aircraft, Inc. Dallas, Tex.—$29,791—Investigation of basic principles of the twin Gyro Reaction Attitude Controller.

Stanford Research Institute Menlo Park, Calif.—$33,030—Research in celestial mechanics and application of nonlinear differential equations.

Regents of the University of Michigan Ann Arbor, Mich.—$117,500—Sounding rocket studies of the ionosphere in collaboration with the Ballistic Research Laboratories.

Regents of the University of Michigan Ann Arbor, Mich.—$270,000—Research involving high altitude radiation measurements.

Stanford University Stanford, Calif.—$122,600—Investigation of very low frequency radio propogation utilizing satellite data.

Massachusetts Institute of Technology Cambridge, Mass.—$75,000—Research preparatory to a short term measurement of satellite gravitational red shift experiment.

Thompson Ramo Wooldridge, Inc., Ramo Wooldridge Div. Los Angeles, Calif.—$47,414—Management and Program Control System.

Southwest Research Institute San Antonio, Tex.—$42,082—Research studies in fuel sloshing in tanks by use of small models.

Grumman Aircraft Engineering Corp. Bethpage, Long Island, N. Y.—$28,897—Research on improved particle-charging techniques.

Southwest Research Institute San Antonio, Tex.—$40,000—Research to identify and determine rate of accumulation of trace toxicants in enclosed systems.

University of New Hampshire Durham, N. H.—$31,280—Develop, construct and test four magnetometer instruments suitable for use on a satellite.

Oklahoma State University of Agriculture and Applied Science Stillwater, Okla.—$48,175—Designing, building and calibrating the instrumentation for two rocket experiments to determine polar conductivity.

Arinc Research Corporation Washington, D. C.—$144,214—Reliability study of Project Saturn.

Massachusetts Institute of Technology Lexington, Mass.—$150,000—Research program in the field of long distance communications via earth satellites and earth-to-space-probe communications.

University of Chicago Chicago, Ill.—$102,727—Research and Development Atlas-Able V in connection with lunar orbiter program.

University of Rochester, River Campus Station Rochester, N. Y.—$46,800—Design building and testing of a gamma ray counter for S16 satellite for the measurement of solar flares.

Princeton University Princeton, N. J.—$138,000—Research on nonlinear aspects of combustion instability in liquid propellant rocket motors.

United Research, Inc. Washington, D. C.—$39,703—Exploratory research program on the relationships of professional groups to formation of government policy regarding the national civilian space exploration program.

Atkins & Merrill, Inc. Arlington, Va.—$25,128—Full scale models of Tiros I

satellite as well as exhibit backgrounds.

Bolt, Beranek and Newman, Inc. Cambridge, Mass.—$46,620—An experimental study and development of analysis techniques for determining human operator dynamic characteristics for application in development of space vehicle manual control systems.

Massachusetts Institute of Technology Cambridge, Mass.—$225,830—Development and manufacture of seven gamma ray instrument packages including three for thermal and flight tests, two for balloon tests and two for satellite flights.

GODDARD SPACE FLIGHT CENTER, Greenbelt, Md.

Aerojet-General Corp. Azusa, Calif.—$992,734—Aerobee sounding rockets and associated components.

Aerolab Development Co., Inc. Pasadena, Calif.—$207,600—Argo D-8 sound rockets.

Airborne Instruments Labs. Division of Cutler-Hammer, Inc. Deer Park, Long Island, N. Y.—$269,808—Airborne ground checkout equipment for ionosphere sounder system for scientific satellites.

University of Alaska, Geophysical Institute College, Alaska—$195,000—Establish a Minitrack station at Fairbanks.

All Products Co. Mineral Wells, Tex.—$32,606—Antennas and spare parts for use in lunar and planetary exploration program.

American Meteorological Society Boston, Mass.—$50,000—Abstracting and publishing articles on space sciences.

Ampex Data Products Company Washington, D. C.—$126,200—FR-600 magnetic tape recorder.

Ampex Data Products Company Washington, D. C.—$96,573—Magnetic tape recorders.

Control Data Corporation Minneapolis, Minn.—$118,135—Data processor and magnetic tape units.

Cook Electric Company, Cook Research Laboratory Division, Morton Grove, Ill.—$228,212—Nine solar beam rocket instrumentation systems for use in sounding rocket program.

Data Instruments Division, Telecomputing Corporation North Hollywood, Calif.—$27,452—Dilog systems for incorporation into data reduction systems.

Electro-Mechanical Research, Inc. Washington, D. C.—$37,859—Telemetry ground station, Washington, D. C.

Electro-Mechanical Research, Inc. Washington, D. C.—$62,115—Digital decommutator and accessories for use in scientific satellites program.

Electronic Engineering Company of California Santa Ana, Calif.—$63,451—Transistor computer format control buffer.

Elgin Micronics Elgin, Ill.—$50,000—Matrix head system flight recorder.

Erie City Iron Works Erie, Pa.—$85,442—Steam generators, pump and heater.

General Chemical Division, Allied Chemical Corp. New York, N. Y.—$52,000—Liquid fluorine for high energy propellant rockets.

General Electric Company, Missile & Space Vehicle Dept. Philadelphia, Pa.—$94,080—System to process biological wastes.

Geophysics Corporation of America Boston, Mass.—$372,568—Instrumentation for determination of composition of upper atmosphere.

Geophysics Corporation of America Boston, Mass.—$149,350—Study of chemistry and physics associated with earth and planets.

Geophysics Corporation of America Boston, Mass.—$255,600—Study winds, diffusion and expansion of gases.

Grand Central Rocket Co. Redland, Calif.—$25,000—Feasibility study of a "nozzleless rocket."

Heron Todd Steel Construction Company, Inc. Arlington, Va.—$84,490—Construct prefabricated wing, Bldg. 4 at Greenbelt, Md.

Hewlett Packard Company Palo Alto, Calif.—$39,102—Electronic counter, installed digital recorder.

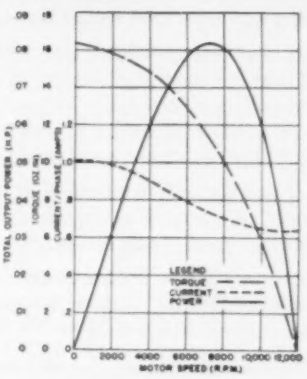
Isomet Corporation Palisades Park, N. J.—$34,892—Carboxy, methoxy and electrocarb systems for use in manned space flight program.

Kennedy (D. S.) Co. Cohasset, Mass.—$72,206—Automatic aiming telemetry antenna and pedestal for tracking satellites.

Newest in Airborne's line of special motors, the HM420 Type is designed for an ambient temperature range of −65° to +600°F. Originally developed for the componentry of a Mach 3 aircraft, it is now offered to the electronics industry in general – both for its particular characteristics and as an indication of Airborne capabilities in the high-temperature motor field.

In basic design the HM420 is similar to motors built to operate at maximum temperatures up to 250°F. In materials of construction it is radically different. Ordinary copper wire windings, for example, oxidize and deteriorate above 400°F, and standard wire insulation coatings have negligible life at 600°F. Thus nickel-clad copper wire is used, insulated with glass impregnated with a specially developed high-temperature additive. Analogous problems have been solved in the case of bearing material, stator plating, soldering, etc. – to assure utmost reliability at elevated operating temperatures.

Whatever your needs in special motors – a-c or d-c – Airborne offers capabilities to meet a wide variety of design requirements, particularly where weight and bulk are critical factors. Write or phone any of our offices. New Product Bulletin PS-8A is available on request.



General Engineering Data — Airborne HM420 Type High-Temperature Motor

Rated Voltage and Frequency: 115/200 volt, 3 phase, 400 cycle induction motor
Life: 20 hr. minimum @ +600°F, plus 380 hr. @ +100°F
Altitude: Sea level to 125,000 ft.
Envelope: 2 in. diameter, 4 in. long
Heat Shock: 150°F/min.
Rated Speed: 12,000 rpm
Rated Hp. .050
Duty Cycle: 1 min. on, 10 min. off
Weight: 1.75 lb. max.

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Some Properties of "K" Monel alloy at Low Temperatures

Condition	Temp. °F.	Yield Strength 0.2% Offset psi.	Tensile Strength psi.	Elongation % in 2 in.	Reduction in Area %
Cold-drawn, age-hardened	Room*	120,000	160,000	20.0	35.0
Cold-drawn, age-hardened	−110	134,600	171,550	17.3	41.1
Cold-drawn, age-hardened	−300	160,200	202,000	27.0	47.3

*Nominal values

Gets tougher and stronger as temperatures go down

"K" Monel alloy also resists oxidation and corrosive attack

In "K" Monel* age-hardenable nickel-copper alloy, the missile designer has a highly useful material for combined strength, ductility and corrosion resistance at extreme low temperatures . . .

This heat treatable alloy starts with high strength and ductility and improves as temperatures drop to −300°F. Consequently "K" Monel components, whether made by forging, welding, or from common mill forms like tubing, perform as well or better at −300°F than at room temperature.

You can add other outstanding properties to the list, too. For instance, "K" Monel alloy has excellent resistance to oxidizers and many types of corrosives.

This same alloy, unlike many non-ferrous materials, also has high heat resistance . . . good strength and ductility and excellent corrosion resistance well into the 1000°-1200°F range.

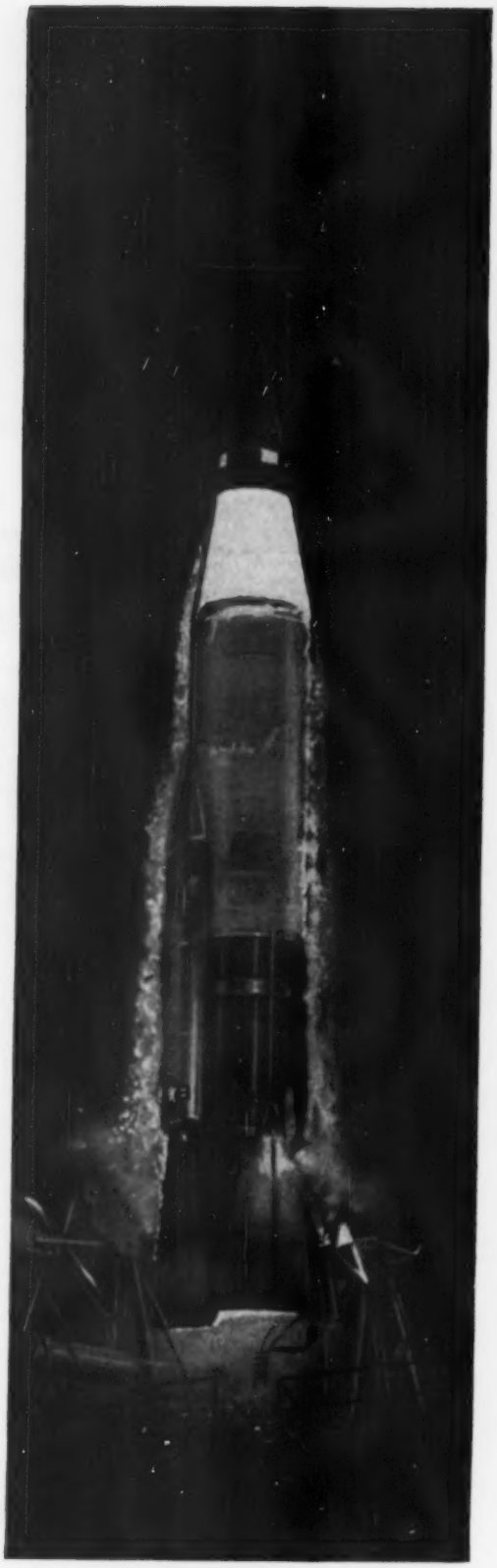
Other excellent low . . . and high . . . temperature alloys

Other Huntington Alloy Products, such as Monel* nickel-copper and Inconel* nickel-chromium alloys for example . . . provide excellent combinations of strength, ductility and toughness at low temperature.

Huntington Alloy Products Division also provides a number of new alloys specially developed for extremely high temperatures . . . Inconel "713C",* a nickel-chromium cast alloy, Inconel "702",* an aluminum-containing nickel-chromium alloy, and Inconel "700",* an age-hardenable nickel-cobalt-chromium alloy. And it's worth noting that these alloys are high performance materials at low temperatures.

For information on low-temperature properties of these standard production alloys, send for "Some Properties of Huntington Alloys at Low Temperatures." Ask about the new high-temperature alloys, too . . . if that's where your special interest lies.

*Inco trademark



HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
Huntington 17, West Virginia

"K" MONEL®

Digressions Cloud Real Research Goal

Digressions from the main goal of research were discussed recently by Ira H. Abbott, director of advanced research programs for the National Aeronautics and Space Administration, at a Princeton University seminar on research planning and management. Because of Abbott's long association with the U.S. research effort and the pertinence of his views in light of currently heightened interest in research, Aviation Week *is publishing his discussion of the problem.*

. . . To a greater extent than may be generally realized, both the quality and quantity of scientific research is dependent on the kind of management it receives. The relationship between quality of research and management is obvious. High quality in research will, in turn, lead to the confidence on the part of general management, whether governmental or private, which is necessary to support the amount of research needed. Good research management can also greatly increase the amount of scientific research by reducing those digressions which occupy the time and attention of many scientists who are supposedly conducting research. . . .

I do not intend to discuss digressions from the detailed goal of preconceived research programs or even digressions from the broader planning objectives of general management. Such digressions are characteristic of research which progresses by following up new observations and thoughts until the emerging pattern may bear little resemblance to that planned. The unfolding knowledge produced by research reveals both possibilities and limitations which make all but our most recent plans seem naive. . . .

Definition of Research

I think of research as the process of seeking new knowledge. I use the word "knowledge" to connote a condition of understanding and to indicate much more than the mere possession of information. The knowledge of which I speak is also new in the sense that it is obtained by the research scientist directly from the study of nature in the light of existing knowledge, and not by the process of education.

Much activity that is called research does not qualify as the process of seeking new knowledge. For instance, the research process includes the acquisition of data or the collection of information but such activity does not, in itself, constitute research. Conversely, all such activity is not included in the research process.

To take an obvious case, we frequently hear it said that an article or book is well or poorly "researched" as the case may be, meaning that the author was well or poorly informed about the facts. If the author works as part of a team, the people supplying the facts may be called "research assistants" or even "researchers." We, who are engaged in scientific research, deplore such use of the word "research," but our self-righteousness might be chastened and our humility strengthened by a close look at some of our activities that constitute digressions from research.

The term "library research" is in good repute today in most laboratories. The scientist must, of course, be familiar with both the information and knowledge generated in his and allied fields by the work of others. The time spent in acquiring this education is essential to him and to the success of his research. It is important, however, to recognize this activity as education which must continue as long as the individual is active and productive, and to distinguish between this activity and research.

Ira H. Abbott, director of advanced research programs for the National Aeronautics and Space Administration, has spent 19 of his 31 years in government managing aeronautical and space research. He joined the old National Advisory Committee for Aeronautics at Langley Aeronautical Laboratory in 1929 after graduation from Massachusetts Institute of Technology. Abbott moved to NACA headquarters in 1947 and was named assistant director of research for aerodynamics in 1950. When NASA was established Oct. 1, 1958, Abbott became assistant director of research for aerodynamics and flight mechanics. He has held his present position since July, 1959.

I expect that most of us with experience in research will recognize the existence of individuals who spend their whole lives in this activity of self education, but who are paid to do research. They become extremely well informed, are frequently recognized as having outstanding competence in their fields, but produce neither a new bit of data nor a new idea.

A few of these people can be very useful in a research laboratory if they are cooperative. No library system can produce pertinent information as quickly as the well informed human mind. Unfortunately such an individual may occasionally acquire such a reputation for wisdom that he may become responsible for the management of research. Then, according to the laws of nature, he reproduces his own kind, and research dwindles or disappears.

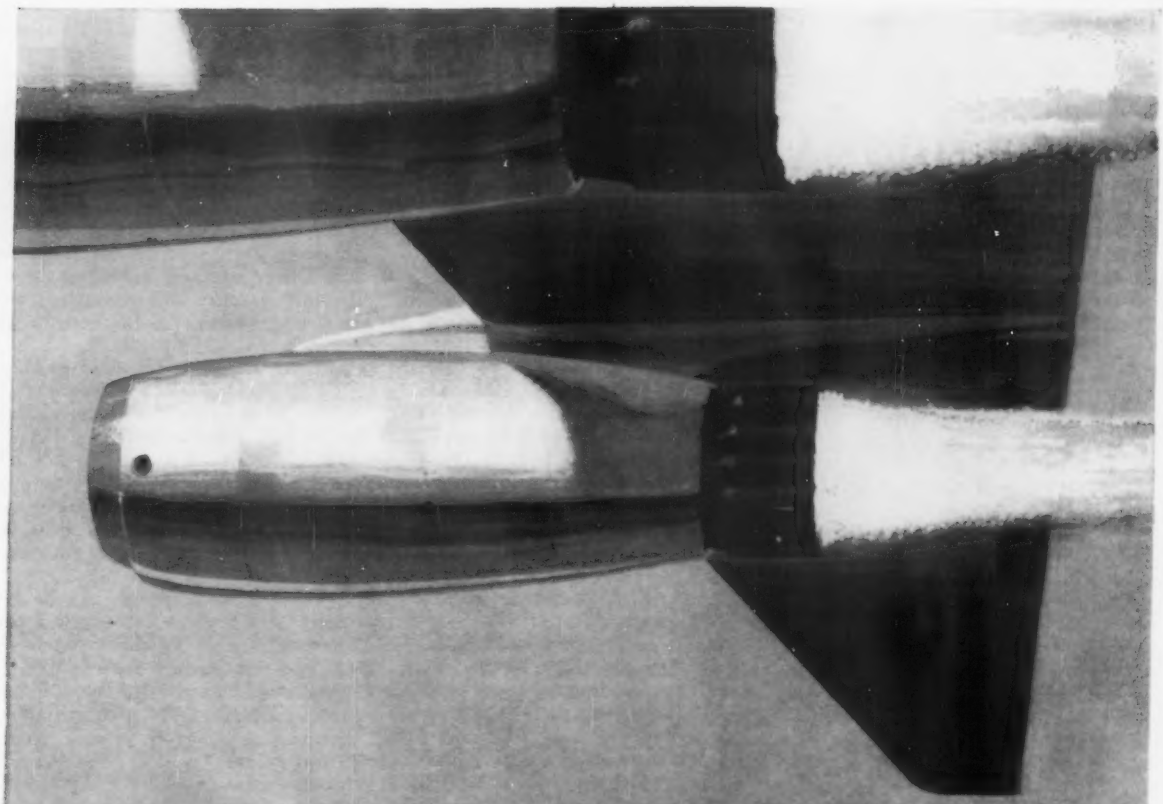
Avoiding Digression

This particular digression is probably the least prevalent of those I shall discuss and the easiest to avoid, once the danger is recognized. Insistence on research activity will frequently change such people into productive scientists, especially if they are in intimate contact with stimulating minds. Recalcitrant individuals must not be permitted to accumulate in the organization or to have supervisory responsibilities.

The second digression I wish to discuss is much more prevalent and difficult to correct. This digression is overemphasis on data acquisition and accumulation, sometimes leading, if uncorrected, to complete discontinuance of research. I would like to quote Prof. Paul Weiss (in Science Magazine) on this point.

"Scientific knowledge grows like an organic tree, not as a compilation of collector's items. Facts, observations, discoveries, as items, are but the nutrients on which the tree of knowledge feeds, and not until they have been thoroughly absorbed and assimilated, have they truly enlarged the body of knowledge.

"Accordingly, if knowledge grows like organisms, we ought to observe sound dietetics and avoid unhealthy over-



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45% of the aircraft oil used by major scheduled airlines in the United States is supplied by Sinclair. Military jets also count on Sinclair to supply Sinclair Aircraft Oil to lubricate their mighty engines. There is no better proof of reliability.

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stuffing: the symptoms of glut—redundancy, superdetermination, oversophistication, and just plain bulk—are already noticeable in current research practices. Part of the syndrome carries rather undignified names, such as 'soft money' or 'projectitis.' But the crucial ailment is myopic vision, which fails to recognize the true character of knowledge. Once out of sight, the body of concepts to which data collection should be related no longer guides the search for data. The sense of relevance and selectivity becomes atrophic, composition stops at sheer compiling, research becomes pointless, and freedom of investigation degenerates into license for random movements."

This is a severe indictment, but I believe that an informed, impartial jury would bring a verdict of guilty to many of our so-called research activities.

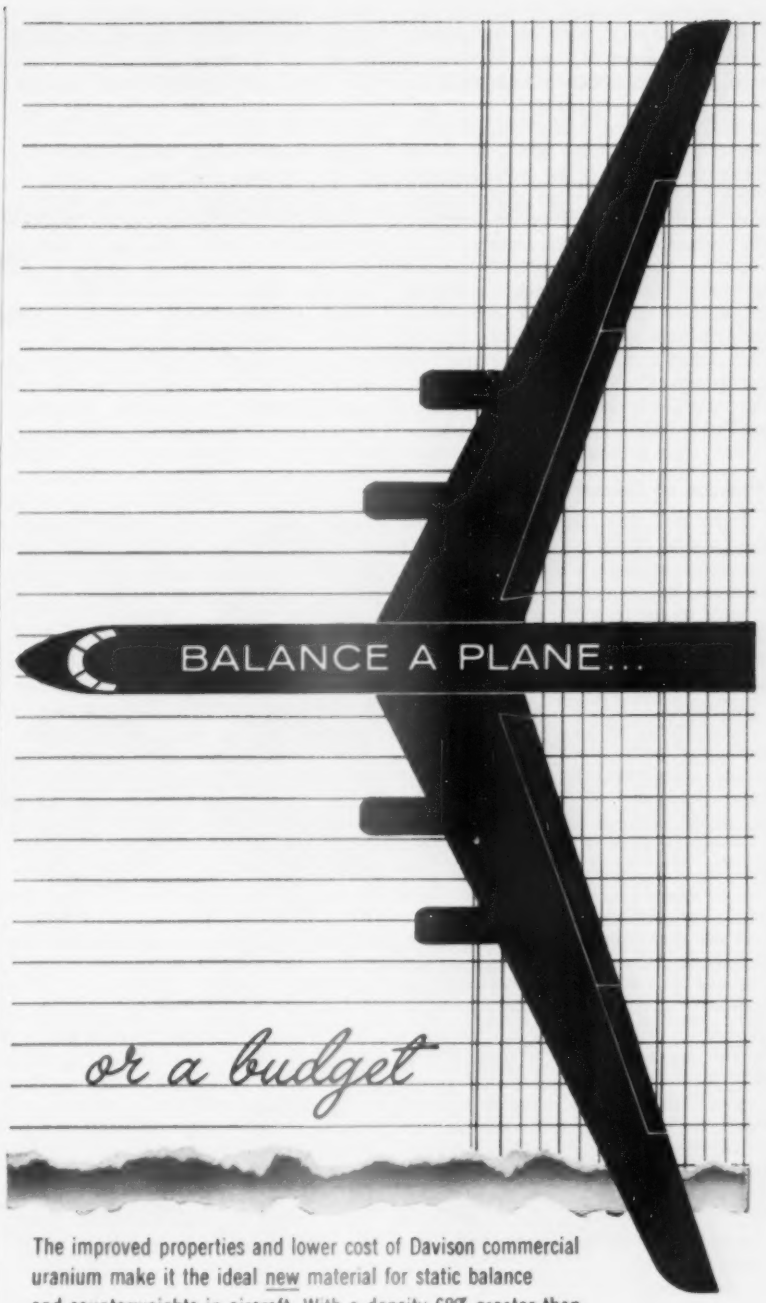
I do not wish to deplore experimental work and the gathering of data which provides the foundation for our scientific process. Neither do I wish to degrade this activity in any way. Experimental work frequently involves the highest quality of skills and innovation to produce the information that is required. The experimental work should, however, be guided by sound scientific thinking to devise the experiments needed to build the theories and understanding that advance knowledge.

I also recognize that the current rapid pace of design and development in some fields demands the accumulation of much data obtained to fulfill practical urgent needs rather than to serve as an economical basis for the advancement of knowledge. Such activities are necessary and proper, and frequently result in progress at a greater pace than would otherwise be the case. But, the reason for such data collection should be recognized, and the work directed to the purpose intended.

There is a point, however, at which the accumulation of data becomes an obsession, an end in itself that serves little useful purpose of any kind. This digression grows like a fungus on the funds and manpower intended for research, showing much outward activity but leaving behind only decay and rot.

This obsession with data accumulation is an attitude of mind which can occur in any laboratory in any scientific field. It is not necessarily associated with any type or size or apparatus used in the process. I fear, however, that the American tendency toward this digression has been encouraged by the availability of very large, costly and complex pieces of research equipment which require teams of specialized people for their operation. This has frequently resulted in organizations geared to the operation of the equipment rather than to the research problems.

These organizations then tend, in



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the American tradition, to become efficient in the operation of the equipment, devising experiment upon experiment with less than adequate consideration of the scientific principles involved, and producing reams of data which are never digested. In extreme cases, much of the data may never be published because the frantic effort to produce more data leaves insufficient manpower for the writing of even data reports.

Such organizations may react to management pressure for a more scientific approach by making matters even worse through reducing even the data analysis and report writing to production line techniques. Once this is accomplished, they will be confident that they have improved enormously and will attempt to sell their methods to other groups.

'Process of Decay'

Even this may not be the end of the process of decay. If the research management is not deluded by the increased efficiency of data production, it may try to correct the situation by consolidating some of the more scientifically minded individuals in special teams not attached to any research equipment.

Such teams are usually given names indicating their occupation in theoretical or analytical research. The equipment operating groups are now deprived of whatever scientific remnants of thinking that they might have retained. The "analytical" groups soon despair of getting the experiments they need to guide their work included in the program and conducted in the manner they desire. Unless headed by unusually talented and forceful people, the "analytical" groups tend to deteriorate after their first successes, and may turn to the paper and pencil equivalent of data production.

The management problem encountered in correcting such an extreme situation is much more severe than that of preventing its occurrence, and may require drastic surgery. The first requirement is, of course, the selection of research personnel who understand the research process as supervisors at all levels of the organization. The second requirement is to provide an organizational structure that encourages research activities rather than mere data production. If it is necessary to organize around large, complex research facilities, three alternative organizational methods of maintaining a research atmosphere are available. All of them can be made to work well, and the best one to use will depend on details of the particular case.

The first alternative is to integrate strong research leaders into each group organized about its own particular facility, and to assure that the head of each such group is primarily research minded. This solution works especially well if the character of the research is such as to permit adequate approaches to important research problems to be made with the equipment assigned to each group with cooperative programs among several such groups brought into play for the broader problems.

The second alternative is the opposite of the first. Each group organized about a particular facility provides a service function for the research groups which are organized in accordance with the research problems to be attacked. This method works well when most of the research problems require experimental work in several facilities to produce the required data. The research personnel, however, must plan the experiments and work in the facilities involved while they are being made if the essential continuity of the research process is to be maintained. This implies that the facility operating groups be reduced to the minimum required to provide maintenance and to assure proper and safe operation.

The third alternative, which is in many respects the best, looks exactly the same as the first on the conventional organizational diagram. Superimposed on this management organizational diagram, however, is a second, or shadow, organization oriented to the research problems rather than to the equipment. Many of the research supervisors wear two or more hats, reporting along the conventional management lines of authority on most matters, but reporting along the lines of the shadow organization with regard to the direction of the research projects.

Effective Organization

Usually the shadow organization is described as research teams cutting across the usual lines of authority. This alternative is sometimes poorly appreciated by management experts, but when properly organized, directed, and understood by the staff it is extremely effective.

The third digression which threatens the main goal of research is meticulosity; the obsession for overemphasis on detail. This digression does not refer to the care which must be taken in research to avoid mistakes and to obtain accurate results. It refers rather to research undertaken to obtain more and more information under conditions where this excessive detail is unlikely to lead to any new fundamental understanding or to produce information of lasting practical significance.

Let me cite one example from my own experience in the field of aerodynamic research concerning the problem of relating the geometry and aerodynamic characteristics of high-lift devices and controls for application to the wings of subsonic aircraft.

Some theory existed to guide this research but it was altogether inadequate to predict the aerodynamic characteristics to the accuracy needed. Accordingly, experimental data were required both to permit better devices to be evolved and to determine their characteristics. The results were sensitive to small changes in geometry such as deflections under load to the surface conditions, to the scale of the experiment, and to the turbulence of the airstream. Consequently, an almost infinite number of conditions existed and many of the research facilities of this country accepted the task of covering as many of them as possible.

Main Problem

The main features of the problem soon became apparent, including the fact that accurate prediction of the characteristics of any design required the testing of that exact design under realistic conditions. Designers were unhappy with this result and insisted upon more and more work in the vain hope that additional research of the same type would change the basic situation. The excessive application of research resources to this detailed problem was brought to an end only when emphasis shifted to higher speed aircraft with more difficult problems.

This is a typical example of meticulosity rather than an especially bad one. Each of you can, no doubt, recall several other examples in almost any field of research.

This example relates to experimental research and accordingly is easily confused with my second digression of excessive data accumulation. The distinction is that data accumulation stops the research process in mid stride while meticulosity applies the complete process to trivial purposes.

Meticulosity is not confined to experimental research, but thrives equally well in analytical activities. I dread to think of the number of fine minds that have spent years of highly skilled but unproductive effort obtaining higher approximations and refining theories basically incapable of accepting such treatment because some assumption used in the original derivation resulted in inaccuracies of a higher order than those being considered. I like to think that these same minds properly directed to take a wider view of the problem would have achieved some noticeable scientific advances.

Meticulosity sometimes results partly from pressure exerted by technically capable but practical minded people. I noted this fact in the example cited. It results much more frequently, however, from intellectual laziness and from the comfort that results from following habitual ruts instead of striking out onto new ground. It frequently happens that

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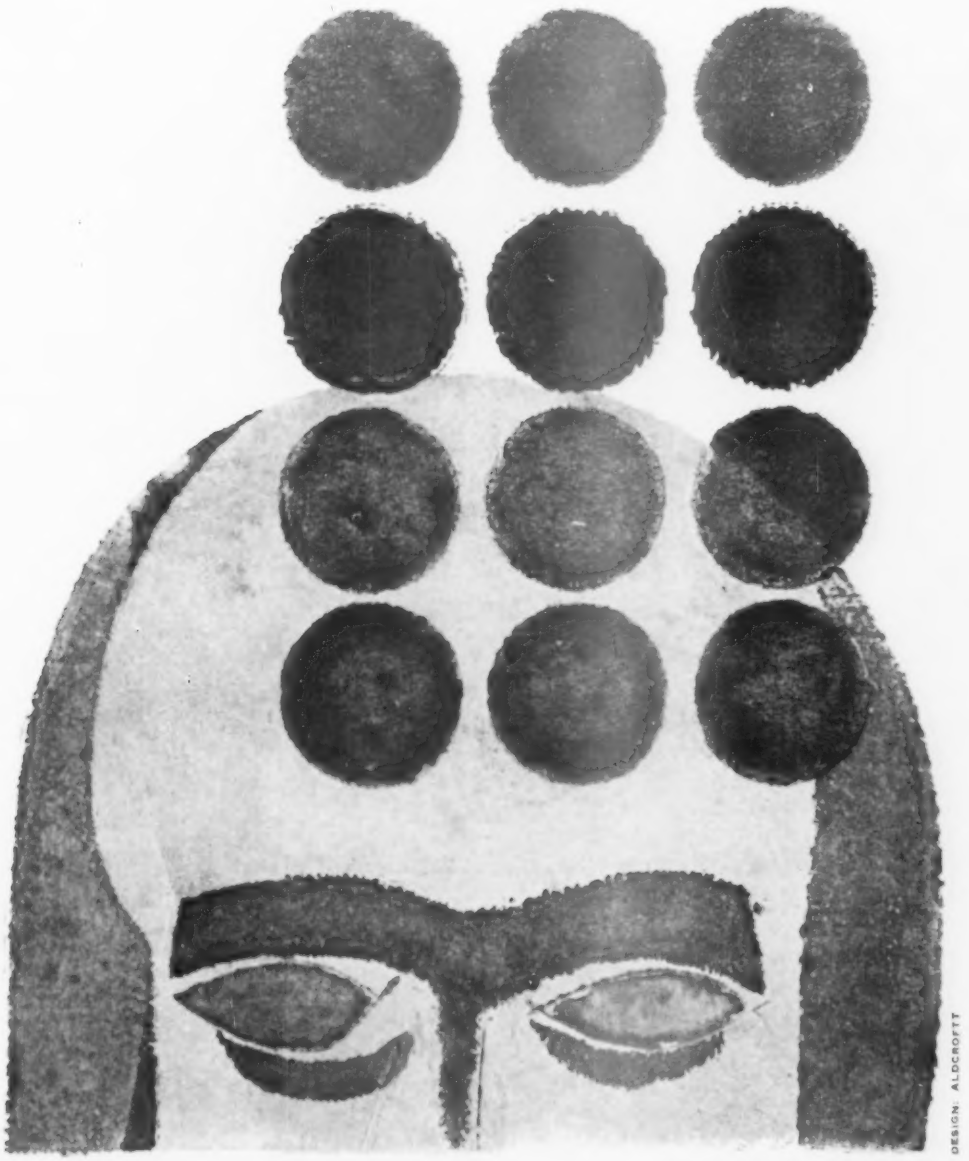

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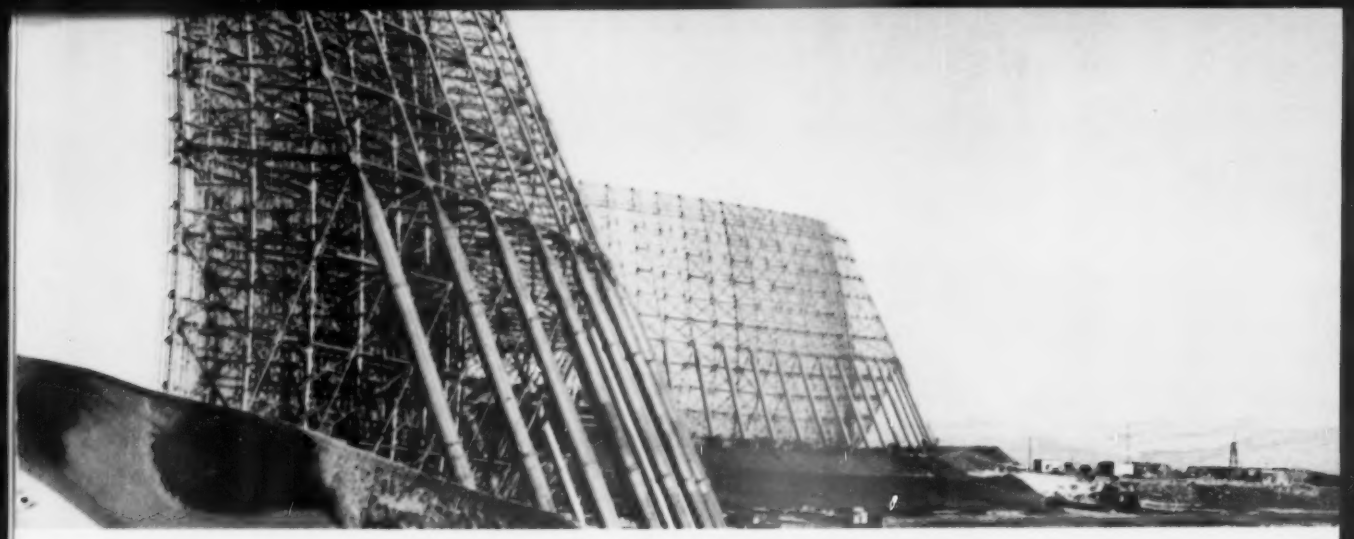

Professional placement report
for Electronics Engineers

How the continuous need to improve the nation's space surveillance capabilities opens avenues for new engineering careers

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individuals or teams who have made substantial contributions to knowledge then settle down comfortably to polish their contributions instead of taking on new problems.

Originally, these contributions usually need further work to correct minor errors and remedy obvious deficiencies. There comes a time when this work is unrewarding and new tasks should be undertaken. It is, however, much easier to continue the old work on which the team has become an outstanding authority than to sail forth into unfamiliar waters where the risks as well as the opportunities are greater. Unless forcibly shaken such teams will continue to run the skim milk again and again through the separator in the hope of finding another drop of cream and will even build bigger and better separators for the job.

Correcting Meticulosity

The correction of meticulosity is one of the most frustrating but most important duties of the research director. In this instance, he cannot always point to the fact that the research is being conducted in a non-scientific manner. The individuals involved invariably wrap the cloak of science about themselves, point to the many details which are always left unresolved, and ask pointedly whether the director is uninterested in the scientific pursuit of knowledge. The best way to correct the situation is, of course, to get the people interested in broader, more important problems. This is not easy but should be pursued diligently.

If not successful, his next step should be to chip away at the team by the gradual transfer of the younger more promising members to other teams where they will have the opportunity for inspecting wider horizons. By the time the team is reduced to a skeleton it may be either abolished completely or left to pursue its course in a small way if the work warrants such activity. Only in rare instances is it wise to abolish a large active team all at once, because such action is too easily misunderstood as evidence of an unsympathetic attitude toward science.

The fourth digression I wish to discuss is habitual sophistry; the practice of indulging in specious but fallacious reasoning in good faith and without recognition of its nature. This digression is only recently becoming of any importance in our practically minded society although it has not been unknown elsewhere in the history of science.

Paradoxically, one impetus to sophistry is the pressure sometimes felt by research organizations to produce practical results faster than circumstances will permit. This leads to the temptation to rationalize or theorize without sufficient information to guide this work. If the results are well received by a scientifically naive management, the process continues.

In the natural course of events, the process becomes habitual, and the results are well received by other so-called scientists engaged in similar activities in other organizations. The practice thus becomes endorsed by a segment of the scientific community itself, and self perpetuating. Even new data or knowledge does not stop this activity, because by the time such data are obtained the individuals involved are no longer directly concerned because they have ventured further into new unknown areas. Then, the individuals or organizations involved may receive acclaim for their previous endeavors because they were among the pioneers, and if their results were finally proven wrong, this is no more than is frequently the case in science. Thus outwardly successful careers may be built on a consistent succession of failures.

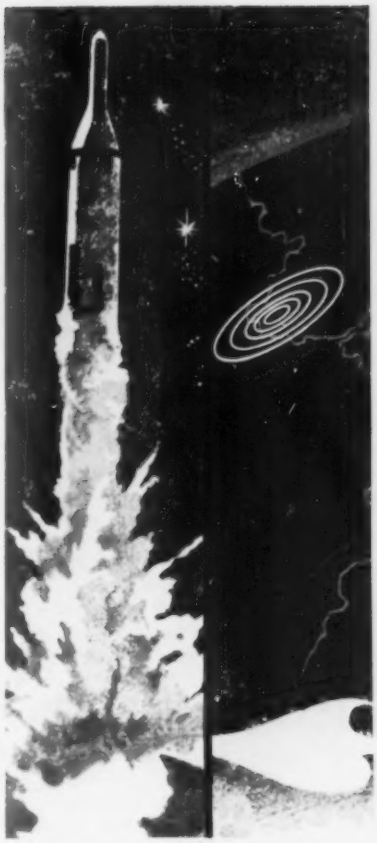
Such sophistry is a burlesque of the scientific process of generating hypotheses on the basis of existing knowledge and observations which are then checked by properly devised experiments, modified or discarded as necessary, and finally accepted as new knowledge. In sophistry, hypotheses appear as conclusions to serve as the basis for more sophistry, and authority tends to replace evidence as at least a temporary arbiter.

Continuance of Digression

Two factors in the environment are essential for the continuation of this digression. The first is long delay in making experimental checks of the so-called conclusions. The second is public interest resulting in publicity. Thus sophistry tends to flourish in such diverse areas as cancer and space research. For examples, I refer you to your daily newspaper. Almost any edition will suffice.

The danger is not merely that this digression encroaches on the slender resources available to research. It is becoming so common, and its proponents so vocal, that those who adhere to the discipline of science are in danger of being charged with lack of vision as the comic-strip and science-fiction picture of science becomes more definitely engraved on the public mind. Some of our largest research-sponsoring organizations are making a virtue of projects that have been refused support by more scientifically minded groups.

It is claimed that, in science, one must take a chance. Nothing is truer in the sense that one does not know what of practical value will result from fundamental research. The claim implies, however, a Monte Carlo approach to the study of nature that is in



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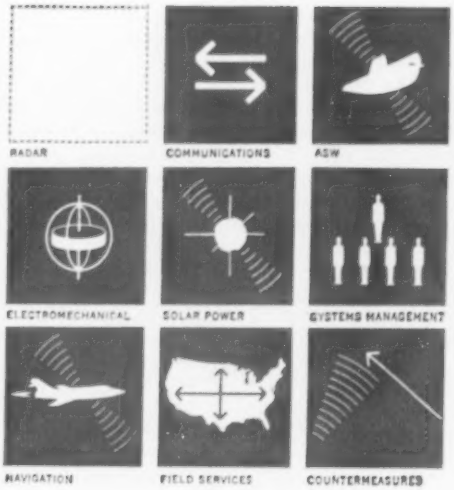

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direct challenge to the scientific process that has been developed in the last few centuries. Scientific selectivity is in danger of becoming old fashioned. Then indeed, in the words of Weiss, will "freedom . . . degenerate into license for random movement."

In this area as in no other, research management needs wisdom to distinguish between the daring and probing mind of the brilliant research scientist and the frequently artistically pleasing but spurious reasoning of the sophist. Research management must have the courage to oppose this activity resolutely, to fend off whatever pressures may be encountered from whatever quarter, and to reduce to a minimum the type of publicity that encourages it.

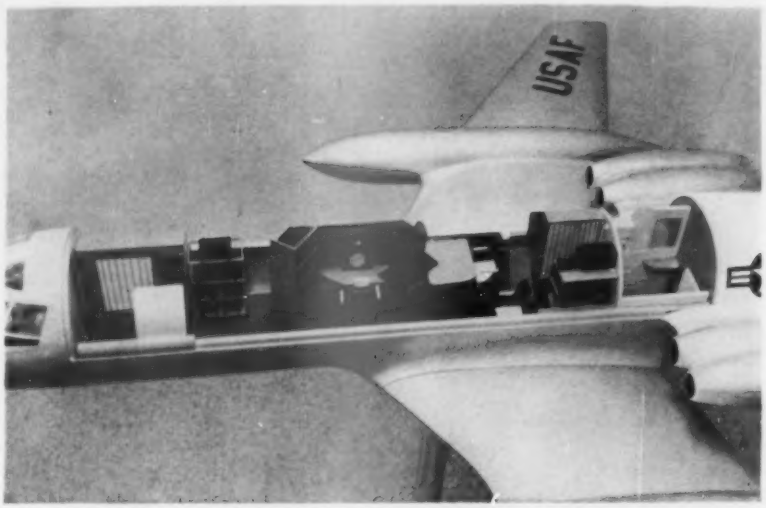
Fifth Digression

We come now to the fifth and last digression I wish to discuss, that of design and development activities. This is in many respects the most serious one, and the most difficult for management to solve.

Let me say now that I do not believe that the large, extensive research activities so characteristic of our time are best conducted in ivory towers, separated and isolated from the practical realities of life. Perhaps some smaller endeavors do need this climate, just as some tender plants need the shelter of a greenhouse. The vigorous forest, however, grows outdoors, subject to all the heat, cold, and tempests of the natural environment. The same is true for research. For the most part science flourishes best as an integral part of life, subject to all the stimulants as well as the buffeting, competition, and harassment that this involves.

Neither do I believe that science, including basic research, needs to be sheltered from the impact of practical needs. Nuclear physics did not suddenly become debased and unproductive when nuclear power was produced, or when some of the tools employed became huge and costly. The exact opposite occurred. Neither has the spur of aeronautical needs made fluid mechanics any less interesting to the scientific mind. Research needs intimate contact and cross fertilization with the minds engaged in putting research knowledge to practical use.

Here we have the problem. How is this intimate contact to be achieved without resulting in practical application crowding the research out completely, or changing its character to a purely supporting role that cannot be productive of new ideas? Research is placed in much the same position as the pilotfish which is traditionally reputed to guide the shark, and is always subject to accidental destruction by his huge partner. It must be spry to snatch its sustenance from the jaws of the shark without actually being swallowed.



JetStar Interior for Checking Navaids

Model of Lockheed JetStar four-engine utility jet, of which five have been ordered by U.S. Air Force for worldwide checking of airways and communications facilities (AW June 27, p. 50), shows avionic layout. At center is Airways and Air Communications Service operator's console, with auxiliary stations at his right. Equipment racks are fore and aft. Aircraft has been designated C-140.

Many people believe that the research activity should be integrated into the organizations seeking to apply research information. In the physical sciences, these are the design and development organizations.

Research Integration

This integration assures close coordination of research and development. In the words of those who do not understand the motivations involved, it also provides the research scientists with opportunities to carry their ideas through the complete process to the end product.

I know of no case where this integration has occurred where both the quantity and quality of the research has not suffered. In the first place, the demands made by development reduce the resources left for research. Whenever there is a conflict for priority, development wins. In the second place, the dwindling research resources are channeled into solving the many existing or easily foreseen development problems until nothing is left for the longer range research. In the third place, the tighter management organization and fiscal controls needed to meet the deadlines and synchronize the many facets of development work produce a deadly climate for research.

The recognition of these facts by general management, whether private or governmental, is sometimes more apparent from their infrequent drastic actions than from their day-to-day decisions. Consider what usually happens when an important so-called "breakthrough" occurs, the exploitation of which requires both research and development activities. Examples in the last 20 years or so include rockets, the nuclear bomb, nuclear power, and radar. Each of you can no doubt name others.

At such times, it frequently becomes apparent to management that no existing organization that can be spared from its current work is really well equipped to exploit the new knowledge, and one or more new organizations are created for the purpose. This recognition of the deficiencies of many existing organizations if carried to its logical conclusion would indicate that they are also usually not well suited to originate or exploit the more mundane new knowledge constantly being produced by research.

Now, let us examine the typical characteristics and history of such a new organization. It is started with a well selected staff composed of brilliant research scientists and excellent design and development men. It is given all required support. The research is of the highest caliber and the information produced is studied and applied immediately to the development of the new product. Unforeseen difficulties encountered in development immediately spark new research activities which sometimes lead to unexpected discoveries. In short, the new organization is a great success and proceeds in short order to produce the practical end item for which it was created.

Then the picture begins to change. The new item needs obvious improve-

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Metallurgical Memo from General Electric

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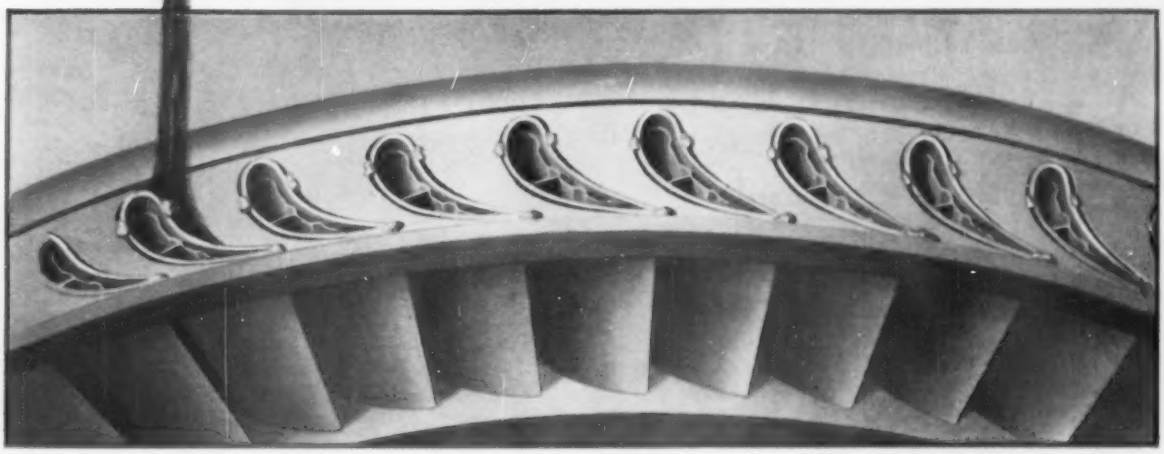

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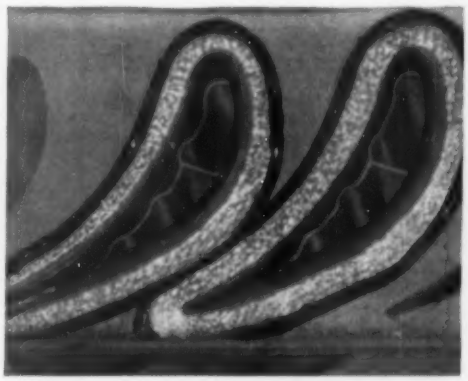

Insert shows vanes completely brazed in spite of gaps. Stains around perimeter of brazes are from stopoffs.

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ments, and new models are developed. The organization has become large and expensive, and management wants the maximum of results for its money. The management is reviewed once or several times, and the lines of control are tightened. The research becomes more closely controlled and directed to more definitive ends. Some of the better research staff drift away. Others see where the grass grows greener and become definitely identified with design and development. The process may take only a very few years or a generation. Eventually the organization becomes a somewhat stodgy development group incapable of producing any startling discoveries and resistant to accepting or exploiting those created elsewhere. We then complete the circle by setting up another new organization.

I have pictured these combined research, design, and development organizations as having a span of life somewhat similar to a living organism. They are born in a vigorous youth, rapidly reach an early productive adulthood, and drift into middle age dullness almost imperceptibly. What is wrong with this? It is certainly one way of life and has been used effectively not only in this country but throughout the western world.

The question is, "Is this process good enough?" My brief description of the process has overlooked two aspects of the problem. The first is the dislocations resulting from the creation of such new organizations. The scientists who are recruited for the new groups tend to come from the universities and the comparatively small number of true organizations which not only produce the new knowledge but are the only sources of properly trained scientists. To the extent that these scientists return to their work as the new organization approaches middle age, this is no over-all loss.

Important Loss

Unfortunately, many never return to science but are lured by better pay, more immediate and definite recognition, and other factors into design and development work, sometimes mislabeled research, where they may be either very capable or very poorly qualified. These lost scientists represent a drain on our training facilities which I do not believe we can long endure.

The second aspect is that these organizations usually do not complete their cycle by dying, at least not at any reasonable age. They stay with us, living partly on their glorious past and partly on the inertia and problems associated with dissolving any organization. They continue to produce new products of almost a routine nature and do it inefficiently and with a conservatism that is a drag on both progress and the general economy.

AiResearch Converts Convair 540 for Napier

AiResearch Division of Garrett Corp. has completed turboprop conversion of first of five Convair 540s that D. Napier & Son, Ltd., will deliver to Allegheny Airlines.

The alternative, I believe, is the separately organized research organization reporting to a high level in the over-all management structure of the company or government. Many of our best industrial research organizations report directly to the president of the company or to some other highly placed official. In government, the National Advisory Committee for Aeronautics was a unique but similarly placed agency whose sole mission was research and which, as an independent agency, reported directly to the President. The National Science Foundation, today, is in a similar position.

Management's Responsibility

The success of this organizational structure will depend upon the quality and vision of the research management. If the research scientists are protected too well from practical problems, they will tend to become too academic in point of view, will fail to meet the expectations of general management and will suffer loss of support. If they are too responsive to the day-to-day problems of development, they will soon go the same way as though integrated into the development work. The trick is to remain alert to the development problems and responsive to such needs without becoming subservient.

The proper research organization must feel full responsibility for making certain that the problems of today, tomorrow, and 10 years from now are identified, that research is started in a timely manner and conducted with vigor to find solutions that are at least acceptable.

It must accept some special chores arising from development problems while retaining its right to reject others that it considers of less importance or capable of solution by other known methods. It must maintain the closest possible contact with development, providing consulting services, and, in return, becoming intimately familiar with the obstacles being encountered or foreseen. It must provide technical guidance to the plans for future developments through the knowledge produced by a broadly based research program, including basic research, without undue restriction by the tentative over-all plans of general management.

The research scientists, themselves, must take the initiative in establishing close liaison and understanding with the development engineers. This initiative is not, in itself, enough, however. By their responsiveness and ability to help they must create an atmosphere in which the development people will actively seek their assistance. Such a research organization can maintain its productivity and vigor indefinitely.

'Insidious Dangers'

I have identified five digressions from the main goal of research endeavors which, I believe, represent the greatest dangers to the future of research in this country. They are insidious dangers, especially because three of them represent activities that are essential and desirable in themselves and which must be undertaken to some degree in all research establishments. The others represent perversions of the research process itself.

The danger lies in mistaking these digressions for research, in permitting them unduly to use the slender resources intended for research, and in the consequent possible disillusionment

of management and the public in the research process itself.

The solution must depend on the willingness of research scientists themselves to accept the responsibilities of research management. The research process is a complicated one and has developed its own management techniques which differ from the more usual ones in relying less on directives and more on convincing technical discussions.

Selecting Managers

I believe that research should be managed by people who understand the research process; i.e., research scientists who have made substantial contributions. If such people are unwilling in sufficient numbers to forego their preferred individual work to make it possible for other scientists to work under proper conditions, research will certainly suffer. Scientists of ability who refuse to participate in research management have little right to complain about the quality of the management under which they work.

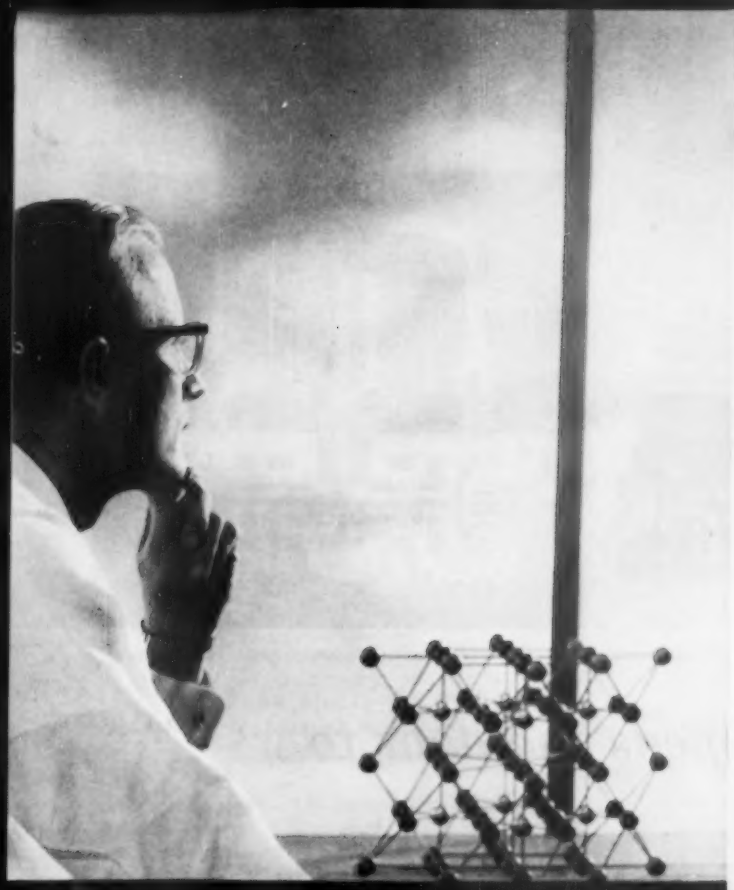
Only research scientists of proven ability can be expected to have the insight to identify the digressions I have discussed from the normal healthy activity of research. Only those who themselves have conducted research will have the sensitivity to the research climate to correct such digressions firmly but with a touch sufficiently soft to preserve proper working conditions. In this sense, I should like to close by quoting an excerpt from a letter written by Oliver E. Buckley, then president of the Bell Telephone Laboratories, to the New York Times and published on Aug. 25, 1945:

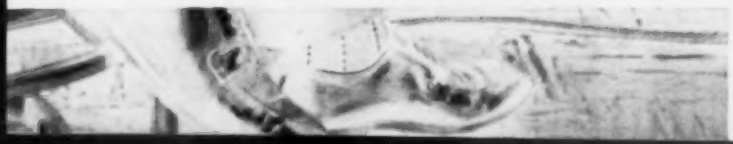
"One sure way to defeat the scientific spirit is to attempt to direct inquiry from above. All successful industrial research directors know this, and have learned by experience that one thing a 'director of research' must never do is to direct research, nor can he permit direction of research by any supervisory board.

"Successful research goes in the direction in which some inquiring mind finds itself impelled. True, goals are set, goals of understanding in the case of fundamental research, and goals of practical accomplishment in the case of applied research. Teamwork increases effectiveness in either case, and the director of research does his part by building teams and seeing that they are supplied with facilities and given freedom to pursue their inquiry. He also insures for them contacts essential to their work, but at the same time protects them from interference or diversion arising from demands of immediate operating needs. He assigns fields of research and broad objectives to the different groups working under his direction, but he must depend largely on those doing the work to find the gaps in knowledge and the opportunities for practical improvements."

British Vigilant Designed for Paratroops

Vickers Vigilant armor-piercing wire-guided missile system weighs 45 lb. The British weapon is launched from its container and is guided by hand-held sight. Range can be varied from close-in to about one mile. An infantryman or paratrooper can operate the missile after five hours of simulator training and three to five live firings, Vickers says. The British War Office has ordered 200-300 Vigilants for infantry trials (AW Sept. 5, p. 34). Production version of the Vigilant is expected to cost about $900 a round.





HEAD IN THE CLOUDS & FEET ON THE GROUND

DOWN-TO-EARTH cost orientation at Motorola begins with disciplined research applied to *creative ideas* and, progressively, pervades every stage of development, assembly, and final production. Ultimately it is reflected in lower field maintenance and support costs consistent with the desired level of reliable performance. This acute awareness of *total* cost versus initial cost, sharpened by more than thirty years of competitive experience and commercial success, is characteristic of Motorola's complete military electronics capability in terms of systems, equipment, and Solid State components.

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- Electronic Warfare & Countermeasures Programs
- Anti-Submarine Warfare Systems & Equipment
- Applied Research & Development in Microelectronics
- Advanced Radar & Sensor Developments
- Solid State Developments in Materials & Devices
- Navigation Systems & Equipment
- Surveillance Systems

More detailed information is available in a comprehensive brochure.

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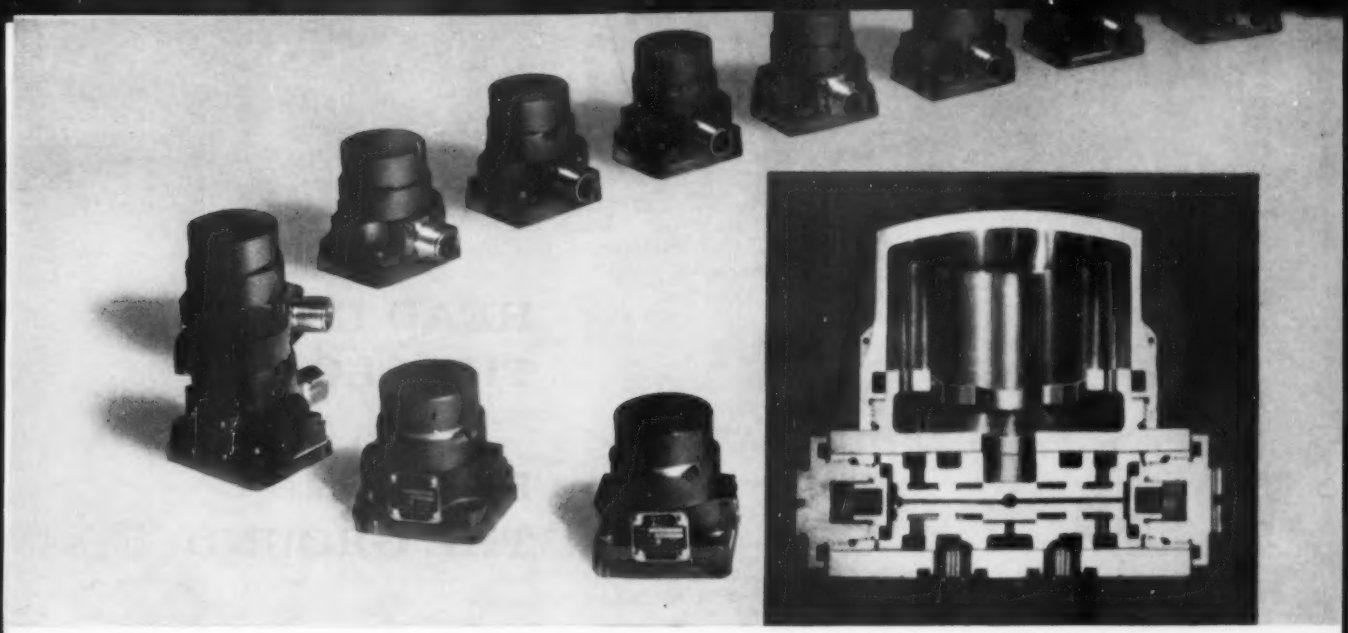

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More and more component parts manufacturers are discovering that titanium clears the way to new profit sources. By substituting titanium for heavier materials, their components are performing better . . . are lighter in weight, more compact and stronger, better able to withstand corrosion, to resist deflection and dimensional loss at high temperatures.

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For technical information on titanium or for referral to competent fabricators of titanium components, call on the Technical Service Department of Titanium Metals Corporation of America, or the TMCA sales office in the city nearest you.

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KEARFOTT: ". . . better machining . . . faster running time . . ."

The all-titanium 6103 electrohydraulic servo valve made by Kearfott Division, General Precision, Inc., is designed for an Army ground-to-ground missile. According to Kearfott, the decision to go to titanium (Ti-6A1-4V) was based on an analysis program that generated the following comparisons:

- **Weight reduction** "Use of titanium in place of stainless steel in all structural members of the valve results in a weight reduction of 28% (4.8 oz)."
- **High strength-to-weight ratio** "Use of titanium in place of aluminum and stainless steel results in a smaller valve, without sacrificing the rugged construction essential to high-pressure hydraulic components."
- **Low thermal coefficient of expansion** "Use of titanium eliminates the danger of loosening shrink fits at elevated temperatures that would occur if stainless steel or aluminum parts were employed."
- **Corrosion resistance** "Use of titanium provides corrosion resistance equal to or better than stainless steel."
- **Machinability** "Because titanium is highly machinable, volume production is easily maintained. For most machining operations, titanium shows better performance than type 321 stainless steel. By utilizing high-powered machine tools at the proper speeds, faster running time was achieved."

VOI-SHAN: ". . . hundreds of thousands of titanium fasteners per month."

The mailed fist of the SAC is virtually held together by titanium fasteners . . . at tremendous savings in airframe weight. An estimated 100,000 titanium fasteners have replaced steel in the B-52G and in the "Hound Dog"-carrying B-52H. The weight-saving is approximately 800 pounds per airframe.

Titanium grade Ti-6Al-4V, used in most of the B-52 titanium fasteners is 43% lighter than steel and is heat-treatable to a tensile strength of 160,000 psi. In addition, it has superior fatigue resistance and atmospheric corrosion resistance.

". . . easily maintaining tolerances . . . of 0.0005"

Voi-Shan Manufacturing Company, Culver City, California, fabricates from titanium three major proprietary fastener types used in the B-52 . . . Hi-Shear rivets, Lockbolts, Hi-Torque bolts, as well as standard hex heads.

Here is what Voi-Shan reports. According to Mr. Tom Harker, Chf. Mfg. Engineer, "Titanium's ease of machining and other fabrication characteristics have enabled us to produce hundreds of thousands of titanium fasteners per month. Quality is high, too. For example, we are easily maintaining tolerances on bolt bodies of 0.0005-in. It's all a matter of proper technique."

RAYTHEON: ". . . helped us overcome . . . turbine wheel distortion . . ."

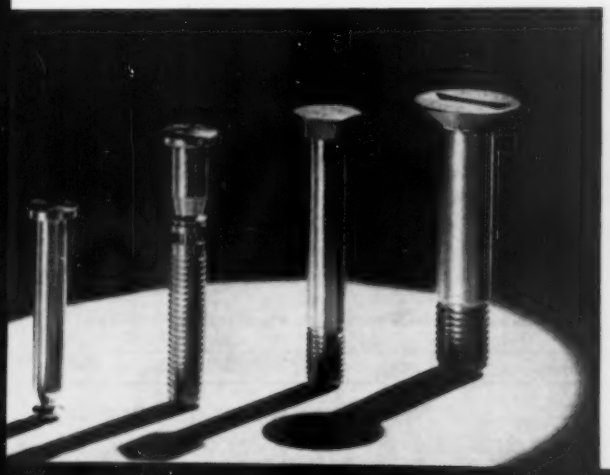
Raytheon Company, prime contractor for the Army's HAWK Missile System, switched from steel to titanium grade Ti-5Al-2.5Sn in the manufacture of its turbine wheel which actuates the missile's electrical power unit. Operated at 24,000 rpm in temperatures up to 1300°F, turbine wheel performance was previously hampered by deflection problems.

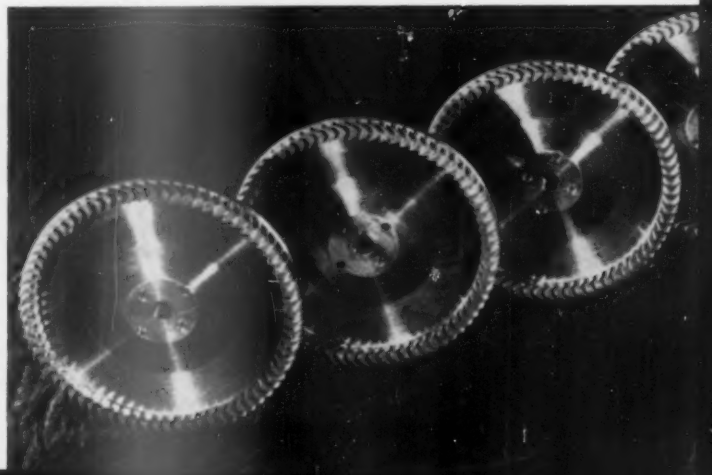
Neil Curran, Project Engineer, says, "Titanium's combination of light weight, high tensile strength and dimensional stability at high temperatures, gives us the solution to wheel distortion caused by build-up of high centrifugal forces during operation."

SCHELLENS-TRUE: ". . . able to reduce our machining price appreciably . . ."

Schellens-True Corporation, Ivoryton, Connecticut, volume producers of turbine wheels such as the Raytheon HAWK missile unit shown, reports a preference for titanium from a manufacturing standpoint.

Vice President E. P. Schellens says, "Since Raytheon changed from stainless steel to titanium for its turbine wheel we have been able to reduce our machining price appreciably while maintaining tolerances to 0.0002-in. and meeting delivery schedules."





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☐ **APACHE.** World's most popular executive twin. Carries 4 or 5 passengers in big, quiet, roomy cabin. Cruises over 170 mph; has cruising range of up to 1250 miles. Powered by two 160 hp Lycoming engines. **$36,990.**

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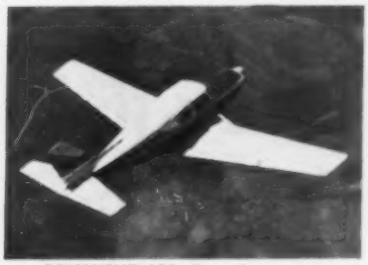
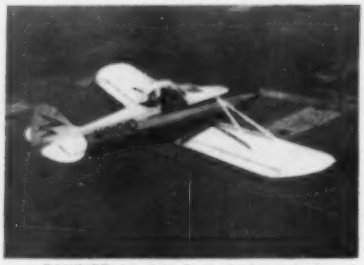


☐ **COMANCHE 180.** Tops for economical transportation, cruises 160 mph with 180 hp Lycoming. Like Comanche 250 has many advanced aerodynamic features—laminar-flow wing, single-piece stabilator. Holds Class 3 record—6959 miles! **$15,800.**



☐ **PAWNEE.** World's first airplane designed solely for application of agricultural chemicals to go into volume production. Combines many special safety features. Has high efficiency dispersal equipment for dust or spray. **$8,995.**

☐ **TRI-PACER.** Fastest in the low-cost 4-place field. Cruises 138 mph with new optional speed fairings. Combines most features to make flying easy—simplified controls, Hydrasorb tricycle gear. **$9,345.**

☐ **CARIBBEAN.** Lowest cost 4-place plane, with 150 hp Lycoming. Has same fine features as Tri-Pacer, cruises over 130 mph. Ideal for operators, flying clubs, businessmen. **$8,795** — as little as $248 per month.

☐ **SUPER CUB.** Modern version of one of world's most famous airplanes. Trainer model has 90 hp Continental; 150 hp model widely used for patrol, mountain rescue, hundreds of other uses. **$6,145.**

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☐ Apache	☐ Tri-Pacer	☐ Pawnee
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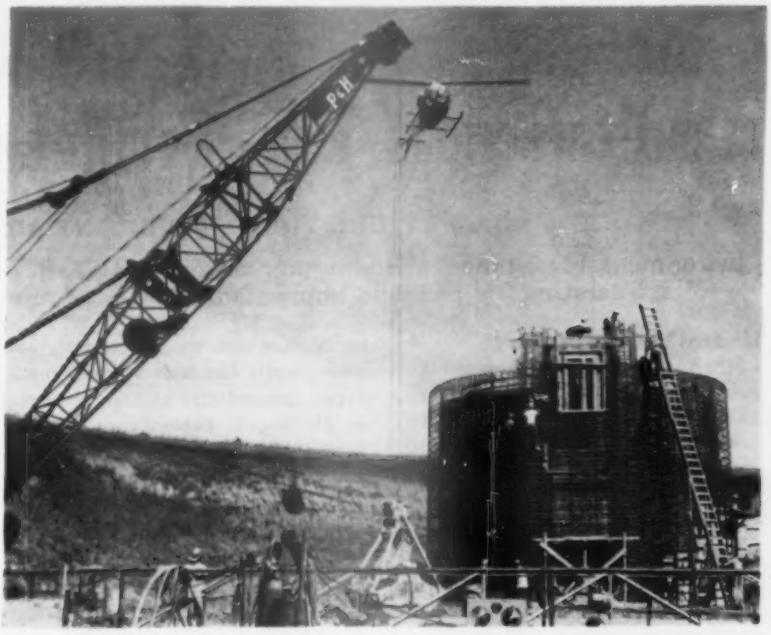
Helicopter Triples Missile Site Coverage

Ft. Worth, Tex.—A major construction contractor in the USAF strategic missile base program is tripling the daily supervisory capacity of key personnel through full-time use of the company's own helicopter.

Western Contracting Corp., Sioux City, Iowa, experience with its three-place Bell 47G-2 Trooper helicopter has been so favorable that it recently purchased a four-place 47J Ranger to provide even greater flexibility and speed for management and supervisors in seeing that work on the 12 underground hard-site Convair Atlas missile stations it is building under a $27 million contract from the U. S. Corps of Engineers stays on schedule.

Western's experience is significant in that it indicates how rotary wing aircraft can play a vital role in a critical defense area, aspects of which are under fire from military, government and civilian critics because of slippages, particularly in base construction and activation. How many helicopters are already being used by other contractors themselves or on a charter basis is unknown, but there is a strong probability that a good-sized market exists for extended use of these aircraft in this area, with requirements bound to grow over the next five years. Atlas and Titan sites alone represent a tremendous construction task and the advent of Minuteman, which is programed for many more times the number of missiles than the first-generation types, indicates a strong future for increased use of rotary wing aircraft in supervising this construction work load.



PILOT Bill Keller accepts a priority part for delivery to one of 12 Atlas sites. System minimizes breakdown delays in construction. Below, helicopter arrives at site.

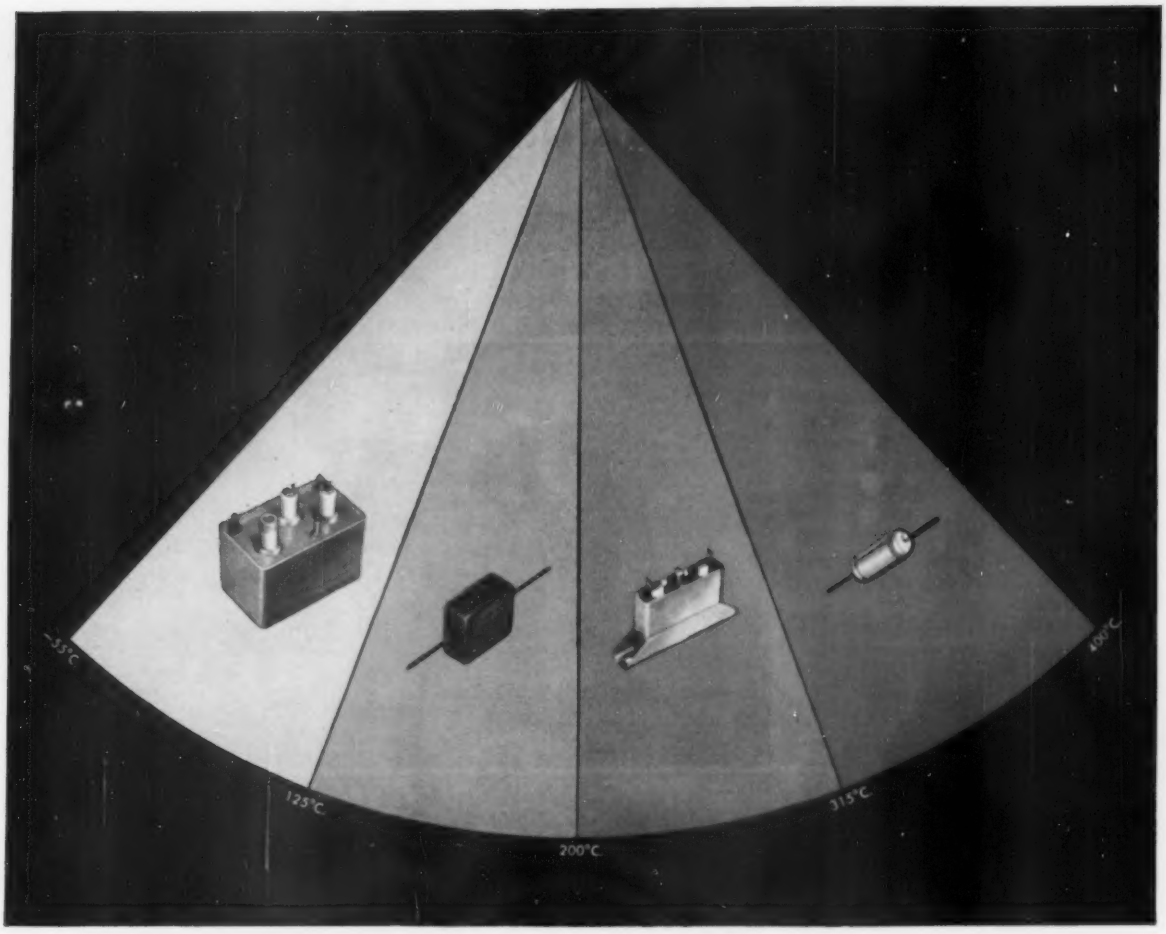
Site Patrol

Industry observers also believe that once the sites are completed, helicopter utilization should continue at a high rate because of the need for monitoring the dispersed and isolated sites and providing speedy transportation for critical equipment to correct deficiencies of aircraft on station.

Some firms believe that some aspects of site maintenance may be contracted by the Air Force to civilian operators. Since these areas are naturally isolated, the helicopter's inherent VTOL characteristics, obviating need for putting in costly airstrips, appear to make it particularly attractive for this long-term mission.

Western Contracting's experience to date highlights helicopter efficiencies in providing sorely needed fast transportation in support of a missile site program. The dozen Atlas underground launching sites it has responsibility for are located within a 60-mi. radius of Lincoln, Neb., a circuit of some 500 road miles.

The problems of spreading management-supervisory personnel over this area, with construction at all the sites going on simultaneously, and a continuous flow of change orders and other complications requiring almost daily reshuffling of work, personnel and equipment schedules—were brought to the



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• Size and weight reductions at high voltages • Drift—.25% capacitance change typical from −55°C. to +125°C. • High I. R.—1500 megohm X microfarads typical at 125°C. • Solid impregnants—no liquid leakage.

125°C. to 200°C.—Available soon
• .001 to 6.0 mfd., 200 V to 3 KV, specials to 10 KV. • Molded end metal housed; tubular and rectangular • Size and weight reduction—over plastic film and stacked mica types, particularly at high voltages • Drift—1% capacitance change typical from −55°C. to +200°C. • High I. R.—50 megohm X microfarads typical at 200°C. • Proved in 4 years' usage.

200°C. to 315°C.—In production
• .05 to 4.0 uf, 600 V and up • Drift—3% capacitance change typical from −55°C. to +315°C. • High I. R.—10 megohm X microfarads typical at 315°C. • Nothing smaller at 315°C.

315°C. to 400°C.—In development
• .001 to 6.0 uf, 150 V and 600 V • Drift—5% capacitance change typical from −55°C. to +426°C. • High I. R.—1 megohm X microfarad typical at 400°C. • Prototype availability • Only inorganic materials used.

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THE Bendix CORPORATION

Charter Contract

Mesa, Ariz.—A charter helicopter operator here, PDQ Helicopter Airways, has taken delivery of a Bell 47G-3, which it will use to handle a one-year contract from contractors building an Atlas missile site at Walker AFB, Roswell, N. M. The contract, which has a renewal option, will provide contractors with the aircraft, a pilot and necessary maintenance and approximately 100 hr. monthly utilization.

Construction firms involved at the Roswell site include: Macco, Raymond International, Kaiser and Puget Sound & Drydock.

company's attention early in the project.

"Management people were needed everywhere at once," assistant project manager Malcolm G. Schaller said. "It was impossible." Company executives started feeling the grind of being in automobiles up to 10 to 12 hr. a day and became frustrated with the impossibility of handling the problems in the limited time available.

Western purchased the 47G-2 from Bell in mid-July. The helicopter has cut in-transit time by two-thirds, the contractor estimates, which means that the company is getting a saving of 80 top management hours a week. People visiting sites in the rotary wing aircraft can visit as many as eight in a single day and of the 10 hr. the man is away from the office he is spending only some two-and-a-half hours traveling, giving him an average of seven-and-a-half hours on-site. The same coverage would have taken contracting personnel three days by car.

Western expects that its first helicopter will more than pay for itself in one year.

Important factor is that use of helicopters cuts down on work stoppages whenever management inspections or decisions are needed before work can proceed. From even the most distant site, manager Mason Travis or Schaller can reach a "hot" site within an hour and a half at most; the same trip by car would take up to a half day, depending on where the car was at the time the radio call came in.

To Western as well as other contractors engaged in this high-priority work, these time savings mean money in the bank. In addition to its own costs, the company will be penalized in dollars for every day the project runs past its scheduled completion date—which for Western is July, 1961.

The helicopters are also used to assemble management people for hastily called meetings, or for taking important visitors, such as USAF or Corps of Engineers officials to the construction sites. They are also used for getting small parts to a site in a hurry. With two Bells available, one will be used primarily by Travis and the other by Schaller.

The craft normally land on the rim of one of the site excavations after giving the passenger a quick low-level view of the entire operation. On landing the project staff man goes into conference with the site foreman. How long he stays depends upon what needs to be done. The visits run anywhere from 30 min. to two hours. Often the first stop the helicopter makes is the only one it has been scheduled for; frequently there is a call on the radio from another site requesting the staff man's assistance and he can head for the new area immediately on completion of business.

Helicopter maintenance is performed at night at Lincoln's Union Airport by personnel of Lincoln Aviation Institute under supervision of pilot Bill Keller. He notes that the craft has had a 99% in-commission rate all summer and weather has caused grounding only once thus far.

PRIVATE LINES

Lake Aircraft Corp., Sanford, Me., has sold three of its Lake Amphibian single engine planes to the Thailand Police Department for bush country work and is negotiating for other orders in the Far East. Company is starting a second production facility at Manchester, N. H., where it has taken over the municipal hangar in return for operating the field, according to John F. Strayer, president. Strayer says production, now 60 planes a year, is aimed at up to 150.

Newark Air Service will handle Aero Commander maintenance under contract to Air Carrier, which has taken on a domestic dealership after handling the plane overseas. Roy Gardner, of Aero Design & Engineering, helped set up the maintenance program at Newark Air Service.

Beech Aircraft Corp. has established a Marketing Division, headed by Wyman L. Henry, vice president, to direct world-wide merchandising and marketing of Beechcraft commercial airplanes and products. John F. Allen has been named manager-product development, and Paul E. Allen manager-parts and service operations.

Hiller Aircraft Corp. has sold a Hiller 12E helicopter to the Government of Chiapas, Mexico's southernmost state. Sale is the sixth in Mexico.

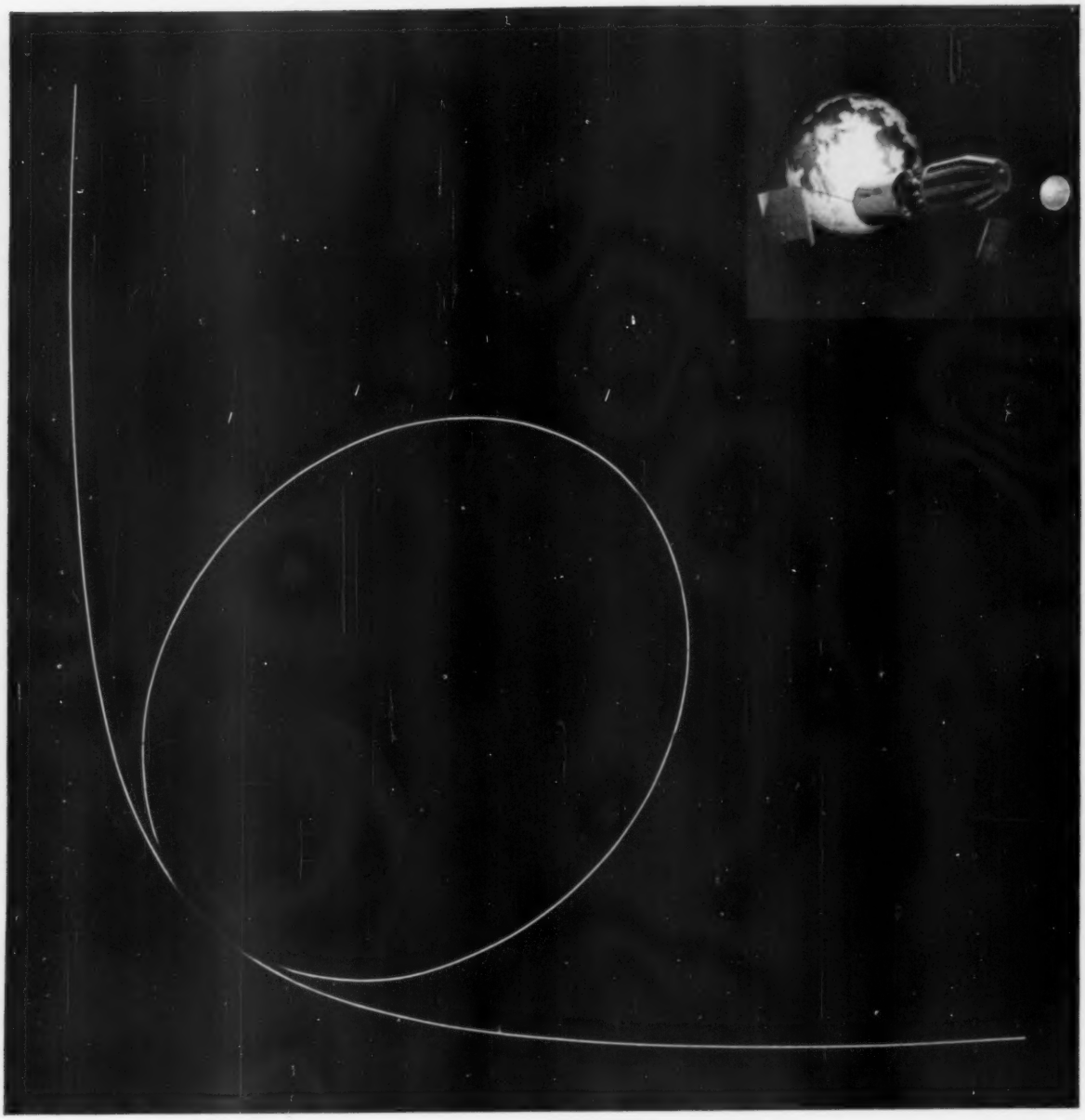
Piper Aircraft Corp. has delivered the first of 20 Aztec twins to U. S. Navy for general utility use. Plane has been designated UO-1; delivery will be completed in October.

U. S. Business & Utility Aircraft Shipments

July 1960

Make & Model	Number of Units	Net Billing Price
Aero Design 300	10	$878,000
560E	1	
720	1	
Beech Super 18	5	$2,589,000
Model 33 Debonair	3	
Model 35 Bonanza	18	
Model 50 Twin-Bonanza	5	
Model 65 Queen Air	6	
Model 95 Travel Air	10	
Callair A-5	2	$29,000
A-6	1	
Cessna 150	30	$3,966,000
172	79	
175	32	
180	21	
182	46	
210	28	
310	25	
Champion 7EC Traveler	2	$121,000
7FC Tri-Traveler	2	
7GCB Challenger	14	
7JC Tri-Con	2	
Mooney Mk. 20	12	$188,000
Piper PA-18 Super Cub	22	$2,093,000
PA-22 Tri-Pacer	33	
PA-23 Apache	19	
PA-23 Aztec	6	
PA-24 Comanche 180	15	
PA-24 Comanche 250	28	
PA-25 Pawnee	29	
Totals	507	$9,835,000

Note: In period January-July 1960, U. S. business and utility aircraft manufacturers have shipped a total of 4,919 aircraft having a total net billing value at the factory of $96,433,000, compared with 4,634 aircraft with a billing value totaling $78,542,000 in the same period last year.



Orbits through space

The space-flight paths diagrammed above represent a closed elliptical orbit, a parabolic orbit, and, on the outside, an open, hyperbolic orbit characteristic of the start of an interplanetary flight.

Orbital flight mechanics is one of the many areas of advanced investigation at Boeing. The staff of the Boeing Scientific Research Laboratories, for example, carries out basic research in such fields as energy conversion, hypersonics, magneto-hydrodynamics and plasma physics.

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CAB Accident Investigation Report:

Lack of Pilot Vigilance Blamed In F-84F, Piper PA-22 Collision

On Nov. 7, 1959, at 1416 EST,[1] a Piper PA-22, N 9609D, and an Ohio Air National Guard F-84F, 519360, collided in the air about 2 mi. south-southeast of the Mansfield Municipal Airport, Mansfield, Ohio. The two pilots of the PA-22 received fatal injuries. The pilot of the F-84F ejected from his aircraft and parachuted to the ground uninjured. Both aircraft were totally destroyed.

The F-84F was the No. 4 aircraft in a flight of four jets making a low-altitude pass in close show formation across the Mansfield Airport from north to south. The PA-22 was on a cross-country flight from Akron to Mansfield and return nonstop. At the time of the collision it was in the Mansfield control zone proceeding in a northeasterly direction. The pilot of the PA-22 did not contact the Mansfield tower. The tower controllers cleared the jets for the low pass after scanning the entire area for possible conflicting traffic but failed to see the PA-22. Weather conditions were good and visibility was approximately 12 mi.

Under the circumstances, primary responsibility for aircraft separation rested with the pilots of each aircraft. The tower operators also had a responsibility to make certain there was no conflicting traffic before clearing the jet flight. It is clear that none of the personnel concerned was exercising the proper degree of vigilance although there was adequate opportunity to do so.

As a result of this accident the Board has recommended to the administrator of the Federal Aviation Agency that all formation flights except those involving simulated instrument low approaches and using an observer aircraft be prohibited in control zones and/or in the vicinity of joint-use civil airports. It has also been recommended that all aircraft that are equipped with radio be required to notify the appropriate communications facility when operating in a control zone.

Investigation

N 9609D was being operated under a lease-purchase agreement by Stadvec Aviation, Inc., of Akron, Ohio. The flight of Nov. 7 was for the purpose of giving cross-country flight training to Mr. Clyde A. Parsons, a student pilot. The flight instructor was Mr. Arthur L. Stanley, an employe of Stadvec Aviation. The flight was planned to be from Akron to Mansfield and return nonstop. It was to be conducted according to VFR (visual flight rules) and no flight plan was filed. N 9609D departed Akron about 1345' and no radio contacts were made with any communications facility thereafter.

F-84F, 519360, was an Ohio Air National Guard single-place jet fighter attached to the 164th Tactical Fighter Squadron, Mansfield, Ohio. The aircraft, piloted by First Lieut. John A. Walter, was one of a four-ship formation training flight.

The four-ship formation, led by Capt. Emerson E. Lewis, departed the Mansfield Airport about 1330 on a local VFR flight plan. In accordance with an Air Force training syllabus it was to perform various formation tactics and training at high altitude, followed by a formation jet penetration and simulated instrument approach.

After the high altitude portion of the training was completed a descent was made in close show formation. Cloud coverage in the area made it impossible to conduct a practice jet penetration and remain VFR, so Capt. Lewis made the descent in an area of scattered clouds approximately 15 mi. northwest of the airport. Capt. Lewis then led the flight underneath the overcast back to the field.

About 10 mi. northwest of the field Capt. Lewis called the Mansfield tower requesting permission to make a low approach across the field with the formation and also requesting landing instructions. Capt. Lewis stated the primary reason for making the low approach was for the benefit of the pilot flying the No. 2 position, Capt. Neel D. Fauber, who was being requalified in the F-84F. Capt. Lewis said the low approach was required as a part of the instrument training and this pass was to give Capt. Fauber experience in flying close formation at slow speed.

At this time the formation was on a heading of 170 deg. at 3,500 ft. The airspeed was 300 kt. and the four airplanes were in close fingertip formation with the element (aircraft Nos. 3 and 4) on the right.

Capt. Lewis stated that after permission for the pass was received he descended to 2,600 ft. When the flight was about 1 mi. from the field he called the tower once more, giving his position and altitude, and again was cleared for the approach. He said he took the formation across the field at 2,600 ft. (1,300 ft. above field elevation), still on the 170 deg. heading and at a speed of 300 kt.

Southern Boundary

After passing the southern boundary of the airport Capt. Lewis said he started a gentle climb and left turn to avoid an area of reduced visibility over the city of Mansfield. About this time his No. 2 man, who was flying on the left, called him and said the No. 4 man had had a collision. No other members of the flight saw the other aircraft at any time. According to Capt. Lewis, the flight was then at an altitude of 2,800 ft., indicating 280 kt., and in a left bank of about 30 deg.

Capt. Lewis said that in a formation flight the leader was responsible for maintaining

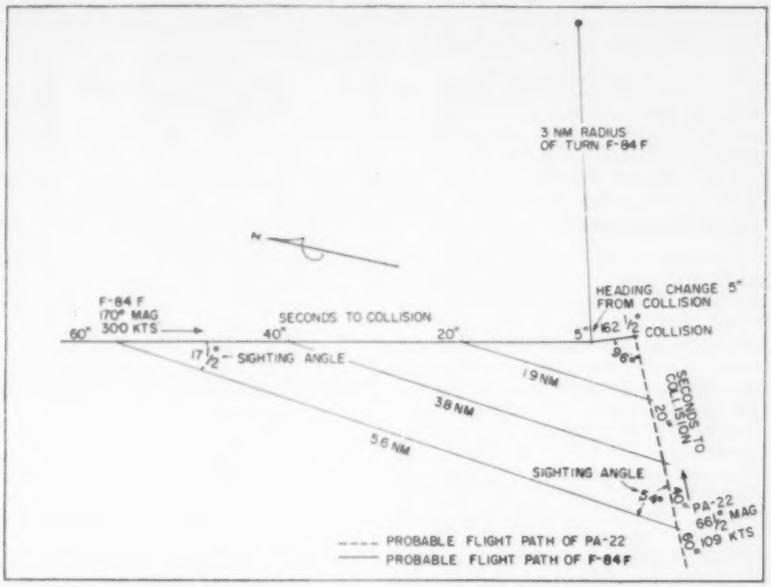

DIAGRAM shows probable flight paths of Piper PA-22 and F-84F which collided at about 2,800 ft. south of Mansfield Municipal Airport, Ohio, fatally injuring both PA-22 pilots.

[1]Times are Eastern Standard based on the 24-hr. clock; altitudes are above sea level, except weather data which are above field elevation.

Rocket-Powered Ejection Seat for F-106

Rocket-powered ejection seat designed by Convair Division of General Dynamics Corp. is being installed in Air Force Convair F-106 Delta Dart all-weather interceptors. Seat rises clear of the cockpit and rotates so that the pilot is lying on his back. Rocket then catapults the seat clear of the plane, permitting bailouts at speeds up to 1,500 mph. Pilot triggers the system by pulling a D-shaped ring between his legs.

an adequate lookout for other aircraft. He said the other members of the flight did not have much opportunity to look around in close formation and had to depend on the leader for separation from other aircraft.

Tower Observation

Personnel on duty in the control tower stated that they recalled only one transmission from Tennis Romeo, which was the F-84F flight radio identification. They said this call was when the flight was approximately 2 mi. north of the field. They said that they saw the flight north of the field and before clearing it both controllers scanned the entire area for other traffic. Seeing none, the flight was cleared. The minimum altitude for an ADF instrument approach is 1,900 ft. (600 ft. above the ground). The controllers said that, based on previous observations of simulated instrument approaches, the flight appeared to be at this minimum altitude but that the speed was considerably faster than would be normal. They said the normal ADF instrument approach is on Runway 13, heading 130 deg., but that this pass was made from north to south across the airport and not aligned with any runway.

Several other witnesses, who were pilots, were in substantial agreement that the F-84's crossed the field at the same approximate altitude as most other aircraft on simulated instrument approaches.

All the witnesses to the accident said that the formation flight proceeded from north to south and after passing the south edge of the field began a turn to the left. The witnesses, some of whom were in the vicinity of the control tower, said the PA-22 appeared to be in straight and level flight on an easterly heading until the collision.

The collision occurred approximately 2 mi. south of the Mansfield Airport, well within the control zone. The PA-22 was proceeding in a northeasterly direction and the F-84F in a southerly direction. The angle formed by the intersection of the flight paths was approximately 78 deg. In addition, the F-84F was in an angle of left bank approximately 30 deg. relative to the longitudinal axis of the PA-22. These relative angles of impact were determined by evidence of deformation and damage to the PA-22 wings, cabin area, engine, and engine mounts, and the F-84F right wing, pylon tank, aft fuselage, and empennage.

A review of the records of both aircraft indicate that they had been maintained in airworthy condition. There were no discrepancies or carryover items affecting the airworthiness of either.

The weather conditions at the time of the collision were: broken to overcast clouds at 3,500 ft; visibility 12 mi.; wind southeast at 4 kt.

Analysis

In VFR weather conditions, primary responsibility for collision avoidance rests with each pilot. In addition, it is expected that pilots will exercise extreme caution when operating in a control zone or in the vicinity of an airport. In this instance the pilot of the PA-22 should have notified the Mansfield tower of his position in the control zone. While this is not required by Civil Air Regulations, it is, in the exercise of sound judgment, a good operating practice to follow in an area of traffic concentration.

A study of the angle at which these airplanes approached one another revealed that both of the pilots of the PA-22 and the leader of the F-84F formation had ample opportunity to see and avoid each other. It is assumed that the PA-22 was on a straight and level course for at least a minute prior to the collision. The sighting angle from the lead F-84F to the PA-22 was approximately 19 deg. to the right of the nose. The sighting angle from the PA-22 to the F-84F formation was approximately 74½ deg. to the left of its nose. These computations are based on relative speeds and the angle of impact and the sighting angle from either aircraft would be constant up to approximately 5 sec. before impact.

The Board recognizes that each wingman in a formation flight must direct his attention to the flight leader and cannot, therefore, maintain a lookout for other traffic. Because of this, it is the responsibility of the flight leader to see and avoid other aircraft and effect proper separation for his entire flight.

The Board cannot accept the reasons given for the low pass by the F-84F formation. First, the Board does not believe that practice in slow flight in close formation can be given at speeds of 300 kt.

Second, the low pass described by the pilots of the flight could not in any way be considered simulated instrument approach training.

Third, the Board believes that the flight descended to the usual altitude at which a simulated instrument approach is discontinued, i.e., 1,900 ft., and not the 2,600 ft. alleged by the F-84F pilots.

Another factor considered in this accident was the responsibility of the control tower operators. The controllers testified that before the formation flight was cleared for a low approach the area was scanned for unreported aircraft. They said this was required to prevent conflict with other aircraft which might be in the vicinity of the airport. No traffic was noted during this visual search and the flight was cleared.

Comparison of the relative speeds of the F-84Fs and the Piper indicates that approximately 1 min. prior to the collision the

Piper was approximately 3 mi. from the tower in a southwesterly direction. At that time the formation flight was about 3½ mi. north of the tower.

Conclusions

The Board concludes that the weather conditions were not a factor in this accident. Visibility was very good and the line of sight from each aircraft to the other was forward in the directions of flight. The F-84F flight leader and both pilots of the Piper had a responsibility to maintain a strict lookout for other aircraft. Although closure speed was high, adequate opportunity existed to see and avoid one another. For these reasons the Board concludes that neither pilot was exercising the proper degree of care expected for collision avoidance.

The Board also concludes that the F-84F low pass was a close show formation demonstration at excessive speed and was not an essential part of the mission being performed and, in fact, served no useful purpose in the training curriculum.

Further, it is concluded that National Guard supervisory personnel at least tacitly were aware of and condoned the practice of the low pass. This is evident in that corrective action initiated after this accident does not prohibit the maneuver. In fact, part of the corrective action is to require that all low passes across the field be made in the landing direction over the active runway.

The Board also concludes that the pilot of the PA-22 should have informed the tower controller when he penetrated the control zone and operated in the vicinity of an airport where a concentration of traffic should be expected.

Finally, the Board concludes that the tower controllers did not conduct a thorough or effective scan of the area for conflicting traffic before they issued a clearance to the formation flight. The Board believes that had they done so they could have seen the PA-22 and been able to inform either it, or the formation, or both, of the presence of traffic.

As a result of this accident the Board recommended to the administrator of the Federal Aviation Agency that all formation flights, except those involving simulated instrument low approaches and using an observer aircraft, be prohibited in control zones and/or in the vicinity of joint-use airports. In addition, it has been recommended that all aircraft equipped with two-way radio be required to contact the control tower or other communications facility when entering a control zone.

Probable Cause

The Board determines that the probable cause of this accident was the failure of the jet formation flight leader and the pilots of the PA-22 to see and avoid one another.

A contributing factor was the failure of the tower personnel to see the PA-22 and take the appropriate action.

By the Civil Aeronautics Board:

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Chairman

CHAN GURNEY
Vice Chairman

G. JOSEPH MINETTI
Member

ALAN S. BOYD
Member

J. S. BRAGDON
Member

Supplemental Data

The Civil Aeronautics Board was notified of this accident shortly after it occurred on Nov. 7, 1959. An investigation was immediately initiated in accordance with the provisions of the Federal Aviation Act of 1958. Depositions, ordered by the Board, were taken in Mansfield, Ohio, on Jan. 15, 1960.

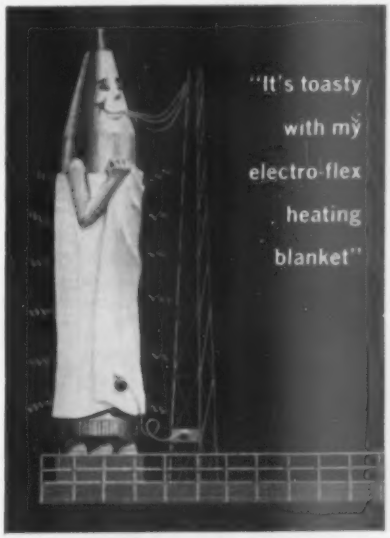
Flight Personnel

Clyde A. Parsons, age 19, was receiving flying instructions. He had a total of 28 flying hours, of which four were in the PA-22.

He passed a medical examination for flying on June 24, 1958.

Arthur L. Stanley, age 50, was employed by Stadvec Aviation, Inc., as an instructor-pilot Sept. 10, 1959. He held a currently effective FAA commercial pilot certificate with single and multi-engine ratings, an instrument rating, and an instructor's rating. He had a total of 11,500 hr. flying time, of which 150 were in PA-22 type aircraft. He passed his latest medical examination for flying on Aug. 27, 1959.

Capt. Emerson E. Lewis, age 38, was employed as an air technician by the 164th Tactical Fighter Squadron of the Ohio Air National Guard in the capacity of flying training supervisor. Capt. Lewis had a military rating of senior pilot and possessed a



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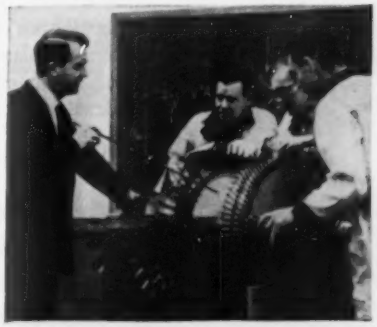

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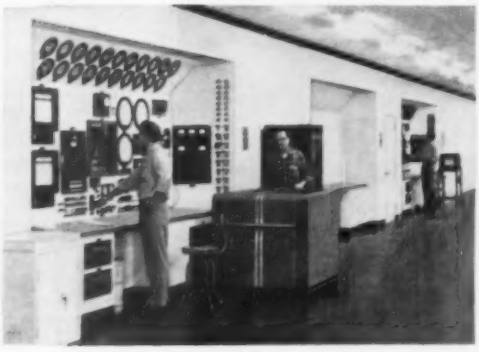

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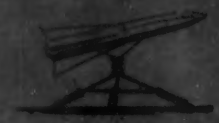

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green instrument certificate. He had approximately 3,500 flying hours, of which about 300 were in the F-84F. Capt. Lewis held no certificate issued by the FAA.

First Lieut. John A. Walter, age 26, was a member of the 164th Tactical Fighter Squadron and was assigned as a pilot. Lieut. Walter possessed a commercial pilot certificate with single-engine land and instrument ratings. He also had a military rating as pilot. Lieut. Walter had a total of approximately 700 flying hours, of which about 265 were in the F-84F.

The Aircraft

PA-22, N 9609D, was operated by Stadvec Aviation, Inc., on a lease-purchase agreement. It had been maintained in an airworthy condition in accordance with factory-recommended procedures. The aircraft was equipped with VHF radio and all appropriate frequencies.

F-84F, 519360, was assigned to the 164th Tactical Fighter Squadron, 121st Wing, of the Ohio Air National Guard. The wing tactical mission requires that unit equipment be maintained in a combat-ready status and, accordingly, the aircraft was in an airworthy condition.

Pilot Blamed in Crash Of Reeve Airways C-54

Washington—Civil Aeronautics Board has determined that the fatal crash of a Reeve Aleutian Airways Douglas C-54B probably was caused by the pilot's failure to observe visual flight rules over hazardous terrain.

Company flight records indicated that the pilot, Capt. Eugene O. Strouse, 49, was overdue a mandatory proficiency check.

These records also indicated that Strouse, chief pilot for Reeve, had taken all of the physical examinations prescribed at six-month intervals for airline captains by the Federal Aviation Agency.

But CAB investigation disclosed that Strouse's last physical was taken on Mar. 26, 1956, and that the captain, according to a local ophthalmologist and the Eye Research Foundation of Bethesda, Md., was suffering from glaucoma as well as cerebrovascular disease.

The Reeve transport crashed Sept. 24, 1959.

Although the extent Strouse was affected by these ailments could not be determined without an autopsy, which was impossible, CAB reports that the two conditions could produce total or partial immobilization, and disturbance of memory, judgment and reasoning in varying degrees.

Strouse's flight was en route to Adak, Alaska, from Cold Bay when it struck the rugged side of Great Sitkin Island at the 2,000-ft. level. Although a 1,500-ft. ceiling shrouded the island, Strouse had canceled his IFR flight plan a few minutes before the estimated time of impact. All 16 persons aboard were killed.

Boeing Contracts for Navy Hydrofoil Patrol Craft

Artist's concept shows 110-ton, 115-ft. hydrofoil patrol craft to be built by Boeing Airplane Co. for anti-submarine operations under a $2,082,000 Navy contract. Subchaser will lift out of the water with the power from its two 3,000 hp. gas turbine engines until the hull is free, then skim at 45 kt. or more, borne only by its hydrofoils in the water. Design contemplates operations up to 250 mi. offshore. Boeing won contract in competition with 11 other companies.

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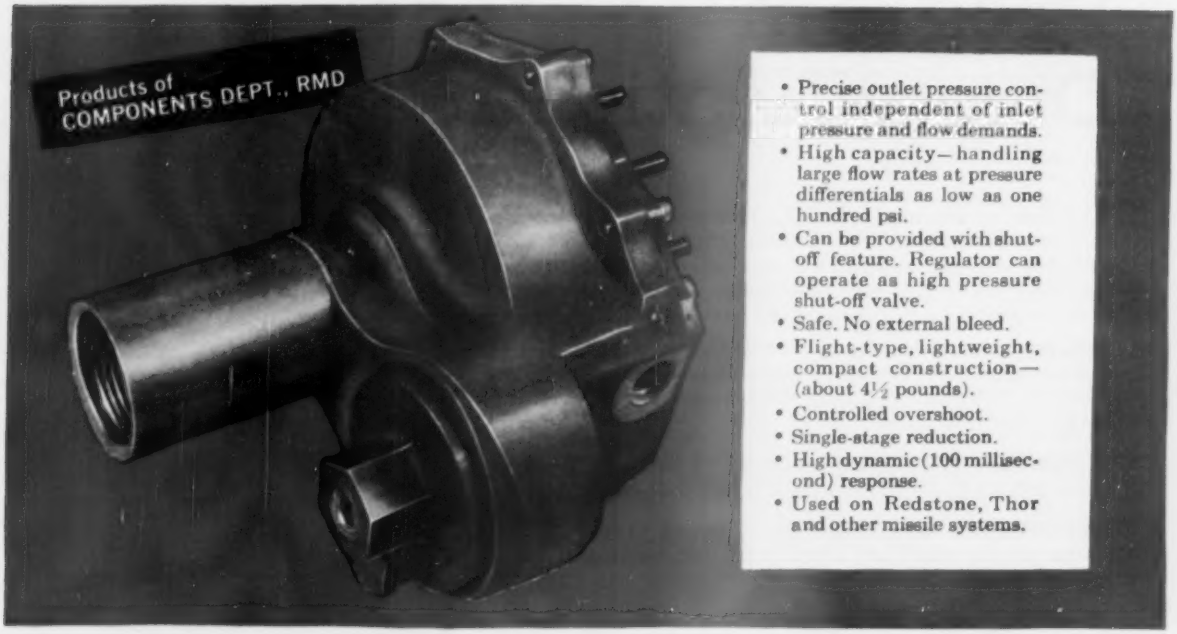

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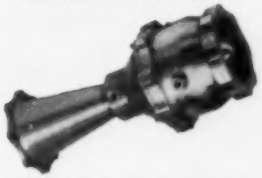

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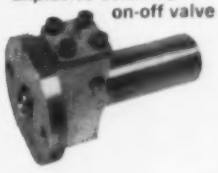

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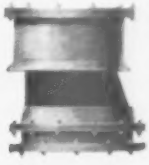

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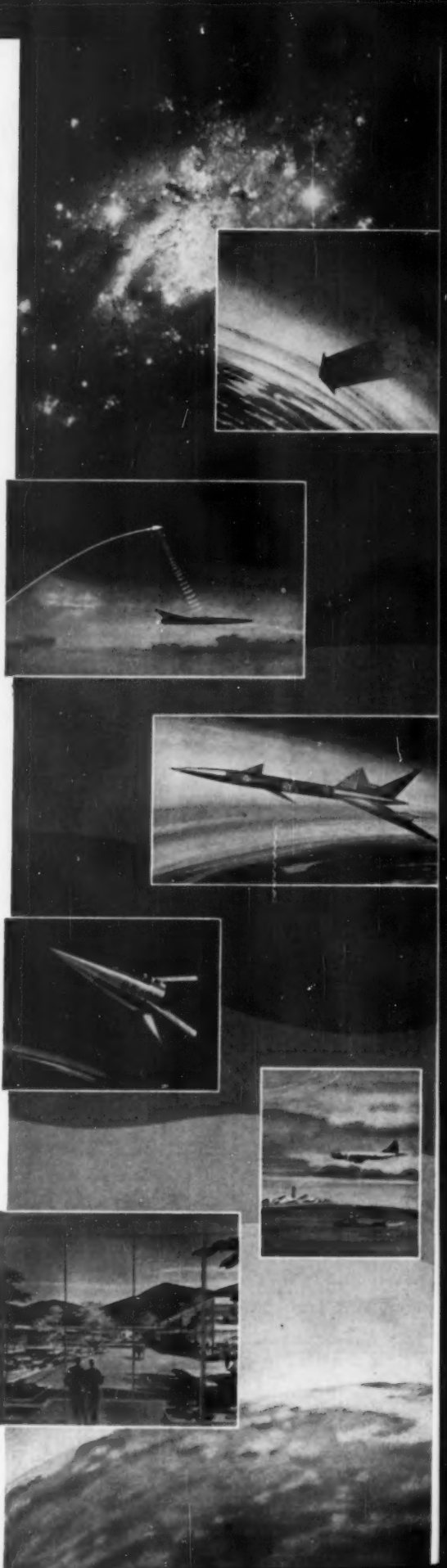

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Please address your inquiry to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1109, 2406 No. Hollywood Way, Burbank, California.

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CALIFORNIA DIVISION

WHO'S WHERE

(Continued from page 23)

Honors and Elections

The **U. S. Air Force**, the **Convair Division of General Dynamics Corp.**, and **Space Technology Laboratories, Inc.**, have been named by the National Aeronautic Association as this year's winners of the Collier Trophy for developing, testing, producing and putting into operation the Atlas, America's first intercontinental ballistic missile.

Dr. Hugh L. Dryden, deputy administrator of the National Aeronautics and Space Administration, has been named recipient of an Elliott Cresson Medal by The Franklin Institute for "his many scientific and practical contributions to the theory and application of aerodynamics which greatly advanced the art of wind tunnel and aircraft design, and . . . the design and development of the world's first automatic radar homing guided missile."

John C. Danhorst, assistant manager of tariffs for Delta Air Lines, elected chairman of the Air Freight Tariffs Committee of the Air Traffic Conference, a division of the Air Transport Association of America, Washington, D. C., and **R. D. Watson**, director of tariffs for Northwest Airlines, vice chairman of the committee.

The Supersonic Tunnel Association has announced the election of the following as officers for 1960; Chairman—**Alan Pope**, head of the Aerodynamics Department of Sandia Corp.; Corresponding Secretary—**Robert E. Covey**, assistant chief, Wind Tunnel and Environmental Facilities, Jet Propulsion Laboratory; Recording Secretary—**K. Orlik-Ruckermann**, head, High Speed Branch, National Aeronautical Establishment, Canada.

Changes

Dr. Lawrence F. Jones, chief-digital group-engineering department, United Aircraft Corp.'s Norden Division, Stamford, Conn.

James R. Rowe, Washington (D. C.) engineering representative for Aerojet-General Corp.'s Spacecraft Division.

Hugh H. Bowe, Jr., director of European operations for Republic Aviation Corp., Farmingdale, N. Y.

J. Norman Rossen, director, Solid Propellant Division, Atlantic Research Corp., Alexandria, Va.

John R. Britt, Eastern manager-rocket motors, B. F. Goodrich Aviation Products Division, with headquarters at Washington, D. C.

Dr. John W. Coltman and **Dr. John K. Hulm** have been named associate directors of Westinghouse Electric Corp.'s Research Laboratories, Pittsburgh, Pa.

John M. Phipps, director of marketing, Electrosolids Corp., Los Angeles, Calif.

Frank P. Melograno, staff director-personnel for Electronics and Space Technology, Thompson Ramo Wooldridge, Inc., Canoga Park, Calif.

Stan Burns, manager of engineering development and programing, Ground Support Division, American Electronics, Inc., El Monte, Calif. **John R. Clifton** succeeds Mr. Burns as director of engineering.

John N. Sherman, project superintendent of the newly created Space Propulsion Department, Hercules Powder Co.'s Bacchus Works, Bacchus, Utah.

J. S. Winter, director of the newly established Special Engines Division, Power Systems Group, The Marquardt Corp., Van Nuys, Calif. Also: **B. T. Morris**, director, Propulsion Division, and **M. F. McConnell**, director, Facilities Engineering Division, Power Systems Group.

Max Elbaum, chief modification engineer, L. B. Smith Aircraft Corp., Miami, Fla.

Thomas E. Davis, manager of the newly created Data Parts and Service Division, Ampex Data Products Co., Redwood City, Calif.

James L. Frutchey, manager-marketing services, Defense Products Group, Daystrom, Inc., Murray Hill, N. J.

Dr. George J. Mueller, chief of development planning, Systems Support Department, Nortronics, a division of Northrop Corp., Anaheim, Calif.

Thomas T. Witkowski, director of Long range planning, Cubic Corp., San Diego, Calif., and **John T. Underhill**, operations manager. Mr. Witkowski also was named assistant to the executive vice president.

Dr. Joseph F. Hook has joined the Senior Staff of National Engineering Science Co., Pasadena, Calif. Also: **Stuart Goff** and **Arnold E. Galef** have joined NESCO's Technical Staff.

work in Southern California on the

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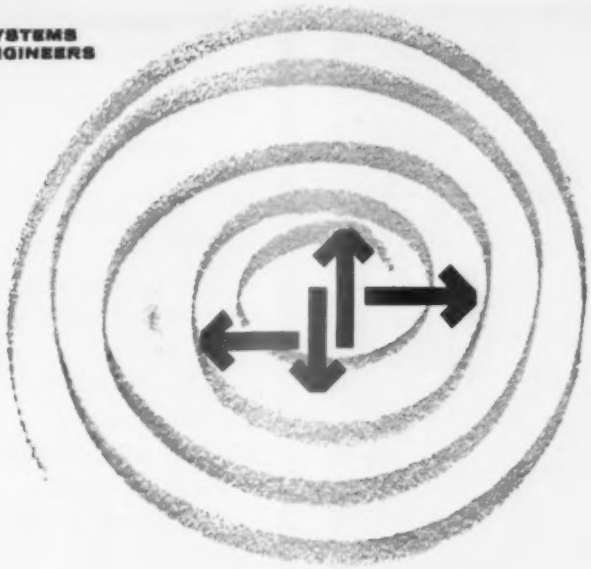

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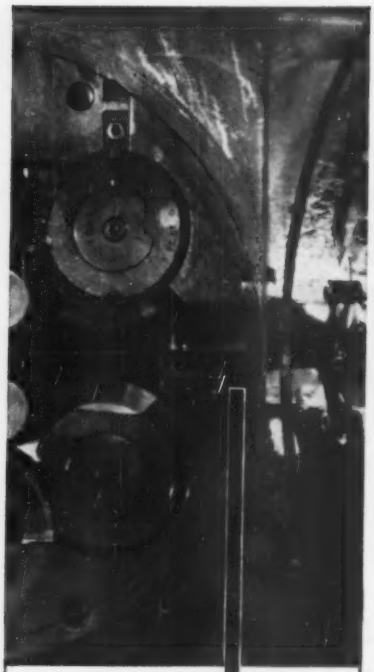

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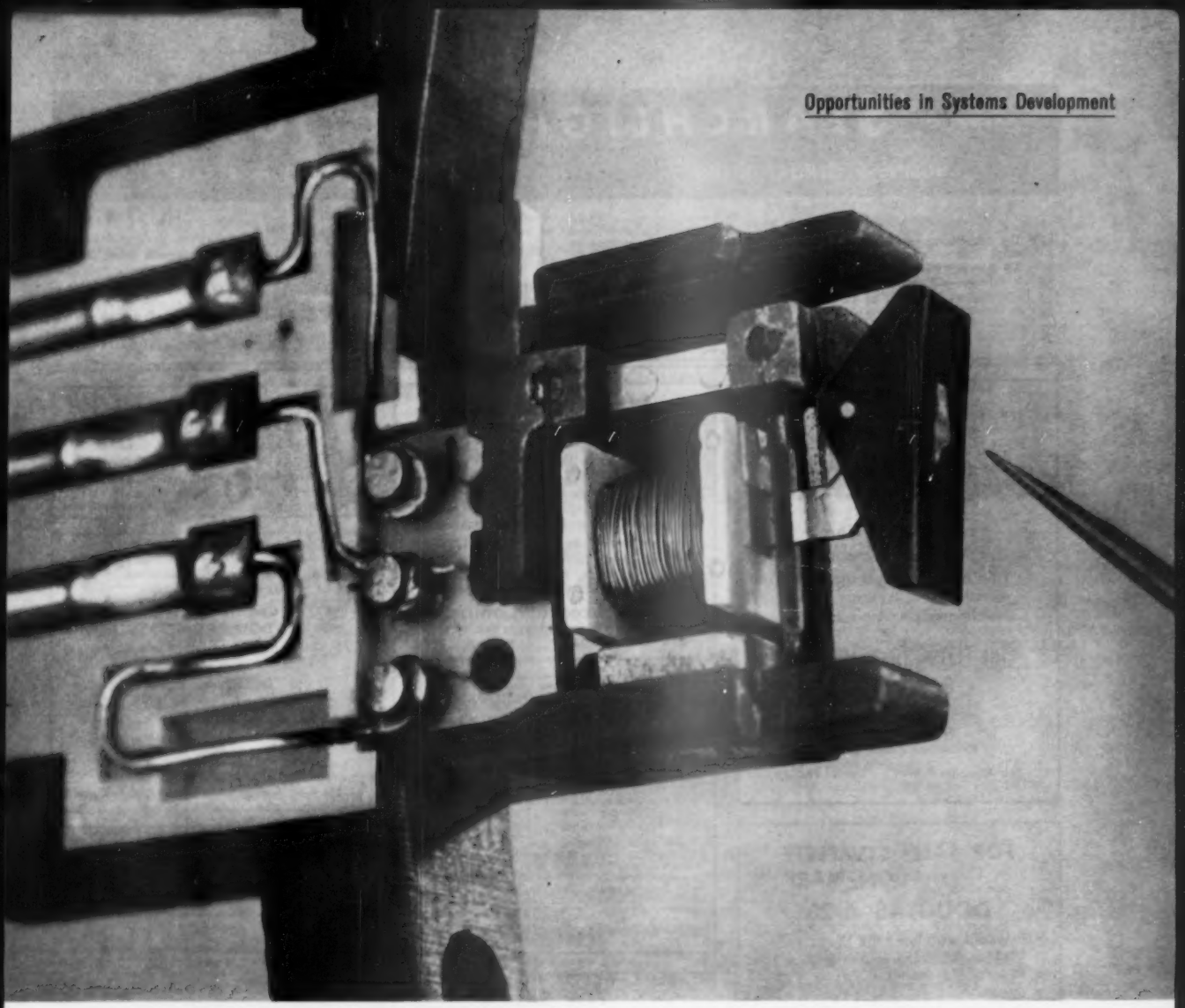
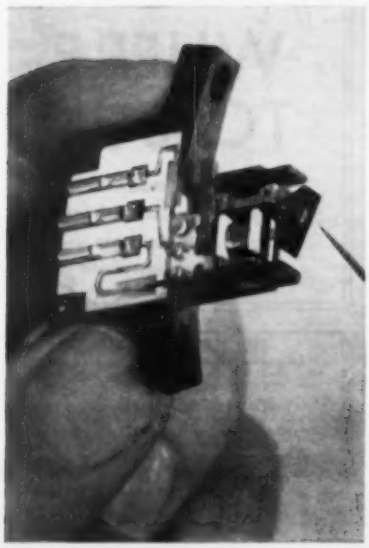


Approximately 5 times actual size, this new read-write head features an air bearing, mechanical lift, and integrated zener diodes.

Floating facts out of computer memory



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LETTERS

Space Communications

Your editorial in AVIATION WEEK, Aug. 8, puzzles me a good deal. You note that AT&T has disclosed plans for a satellite communication system. I suppose that you heard this through a talk given by Mr. F. R. Kappel, president of AT&T, or through testimony presented to the FCC on July 18, 1960. In both the talk and the testimony it was made clear that the Bell System is prepared to bear the expenses of research and development of satellite communication. Yet, in your editorial you say that "It is also apparent that it will be a long time before such a system could offer sufficient return on investment to be tackled by any individual corporation as a profitable private venture."

People at AT&T and the Bell Laboratories don't believe this is so; they believe that satellite communication has a useful and profitable future. Otherwise, they wouldn't have constructed the Echo ground terminal on Crawford Hill at their own expense. And right now some 60 Bell Laboratories engineers, scientists and technicians are working on satellite communication and the number is increasing.

Except for operating expenses in connection with Project Echo, this work is being paid for by AT&T.

J. R. PIERCE
Director of Research-
Communications Principles
Bell Telephone Laboratories, Inc.
Murray Hill, N. J.

(Although the Bell System is one of several companies that is investing its own funds in development and studies of commercial communication satellite systems, and Dr. Pierce was one of the earliest pioneers in this field, the fact remains that no company can afford to implement such a system until it can compete economically with other available transoceanic communication facilities.

In recent testimony before the Federal Communications Commission, Bell Telephone Laboratories' President James B. Fisk indicated that the Bell System would implement a communications satellite system when the state of the art gave assurance of "reasonable technical and economic success." In this FCC testimony, Bell System spokesmen did not disclose even a tentative timetable for possible implementation, suggesting that same would be at least a few years off, as AVIATION WEEK's editorial indicated. The whole point of AVIATION WEEK's editorial was that the international prestige implications for the first country to implement a commercial communications satellite system call for a higher-risk accelerated effort, beyond that which commercial enterprise can economically justify, and this requires a joint government-industry program. We suspect that Dr. Pierce would share our disappointment if Nikita Khrushchev were to be master of ceremonies and principal speaker at the world's first global telecast.—Ed.)

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Aerial Cameras

In rebuttal to Mr. Nash's comments (AW Aug. 15, p. 156), he is apparently unaware of the performance characteristics of either the Fairchild KA-2 or the Chicago Aerial Industries KA-30. First of all, there is the statement: "The KA-30, by no means a standard model, produces a photograph only one-quarter the size and yet has a shutter speed only approximately half that of the KA-2." Wrong on two counts: the KA-30 is a standard camera of which over 150 have been produced to date in accordance with specification MIL-C-22181 and used by the U.S. Navy in A3D-2P and F8U-1P aircraft, and by the U.S. Army in AO-1 aircraft and USD-2, USD-4 and USD-5 surveillance drones. Secondly, the maximum shutter speed of the KA-2 is given by TO 10A1-5-4-1 as 1/500 sec. with the 6 in. *F*:6.3 lens (although a few have been modified to 1/800 sec.) and 1/400 sec. with the 12 in. *F*:4.0 lens. The comparable lenses for the KA-30 are the 3 in. *F*:4.5 and 6 in. *F*:2.8 and the maximum shutter speeds are 1/800 sec. and 1/400 sec. respectively, as specified by TM 11-6720-208-12 (rather unusual to have a TM published for a camera that is "by no means a standard model" isn't it?).

Next, the statement is made that image motion compensation is of little value in high oblique photography. This statement is also incorrect. Let us assume a 12 in. focal length on the 9 in. x 9 in. format of the KA-2, or its equivalent 6 in. focal length on the 4½ in. x 4½ in. format of the KA-30, and a 30 deg. depression angle for the optical axis. This means that the upper ray is at 9 deg. 30 min. depression and the lower at 50 deg. 30 min. In practice, it is generally considered that in extreme low altitude oblique photography, the vertical aspect of foreground objects "shadows" more distant objects, so that at angles of depression of 20 deg. or less, little useful information is gained. Thus, the significant portion of the format is that between 20 deg. and 50 deg. 30 min. If the appropriate IMC for a depression angle of 34 deg. is used, this IMC value will be 150% of the correct value at the 20 deg. point and 50% of the correct value in the foreground, at 50 deg. 30 min. The effective motion blur (or IMC error) is thus at worst, 50% at the extremities and approaching zero as the 34 deg. zone is approached.

This, of course, means that if two cameras have the same shutter speeds, but one has IMC and the other doesn't, under these circumstances, the relative motion blur is as though the IMC camera has twice the motion stopping ability or effective shutter speed. The KA-30 can use its IMC up to 6 cycles per second, whereas the A-28 IMC magazine for the KA-2 (on which we are qualified experts, having built them) is limited to 2 cps. Quite simply, at low altitudes and high ground speeds, you need more than two pictures per second to avoid gaps in the coverage. Therefore you must fly slower or accept gaps in the coverage.

(Incidentally our A-28 magazine supersedes the earlier Fairchild A9B magazine which has a 1.25 cps. rate and lacks IMC.)

Finally, note the disparity in speed of the lenses—6 in. *F*:6.3 vs. 3 in. *F*:4.5 and 12 in. *F*:4.0 vs. 6 in. *F*:2.8. Since the light gathering power of the lense is proportional to the square of the *F* number, the KA-30 can use twice as fast a shutter speed as the KA-2, or put another way, can use its fastest shutter speed at light levels half as high.

Perhaps these are the reasons the Air Force is considering 70 mm. cameras and 4½ in. cameras (among them the KA-30) both to retrofit the RF-101 and as the primary cameras in the aircraft planned to supersede the RF-101. Indeed, if Fairchild Camera and Instrument Corp. has such boundless faith in their KA-2, why did they offer their KA-26 70 mm. camera in the recent Tactical Air Command evaluation test program for the next RF aircraft at Shaw AFB?

JAMES R. DUNN
Manager Service Engineering
Chicago Aerial Industries, Inc.
Melrose Park, Ill.

Phoenix Pilot

It was a great surprise to us to read in the July 18 issue of AVIATION WEEK, p. 102, under the photo of our Phoenix glider, that Ernst-Gunther Haase comes from Poland.

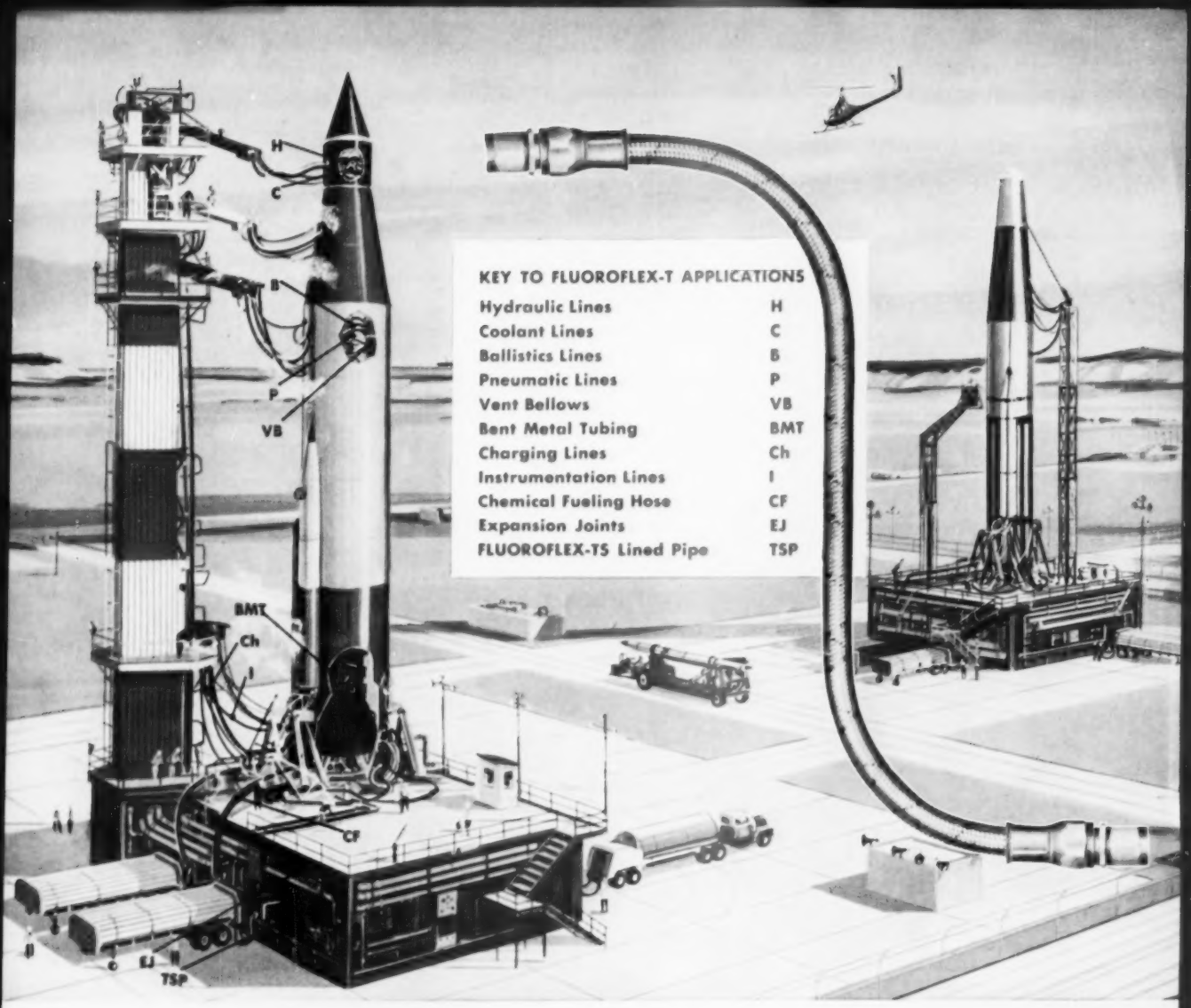
We assume that this is a mistake, but to make sure we consider it necessary to inform you of the detailed situation so that you are able to publish a correction in your journal as soon as possible.

The all-synthetic, high-performance Phoenix glider was designed by Dipl.-Ing. Nagele and Dr. Eppler of the Technical College at Stuttgart. Both men have since joined our firm. Production of this model is now being undertaken by Apparatebau Nabern GmbH. and with the support of Bolkow-Entwicklungen K.G. an improved version with a T-tail has been built.

Dipl.-Ing. Ernst-Gunther Haase is a German.

He joined Bolkow-Entwicklungen K.G. as chief designer some time ago. The only association he had with Poland was when he won the world championship in the open class there in 1958.

BOLKOW-ENTWICKLUNGEN K.G.
Ottobrunn nr. Munich
Germany



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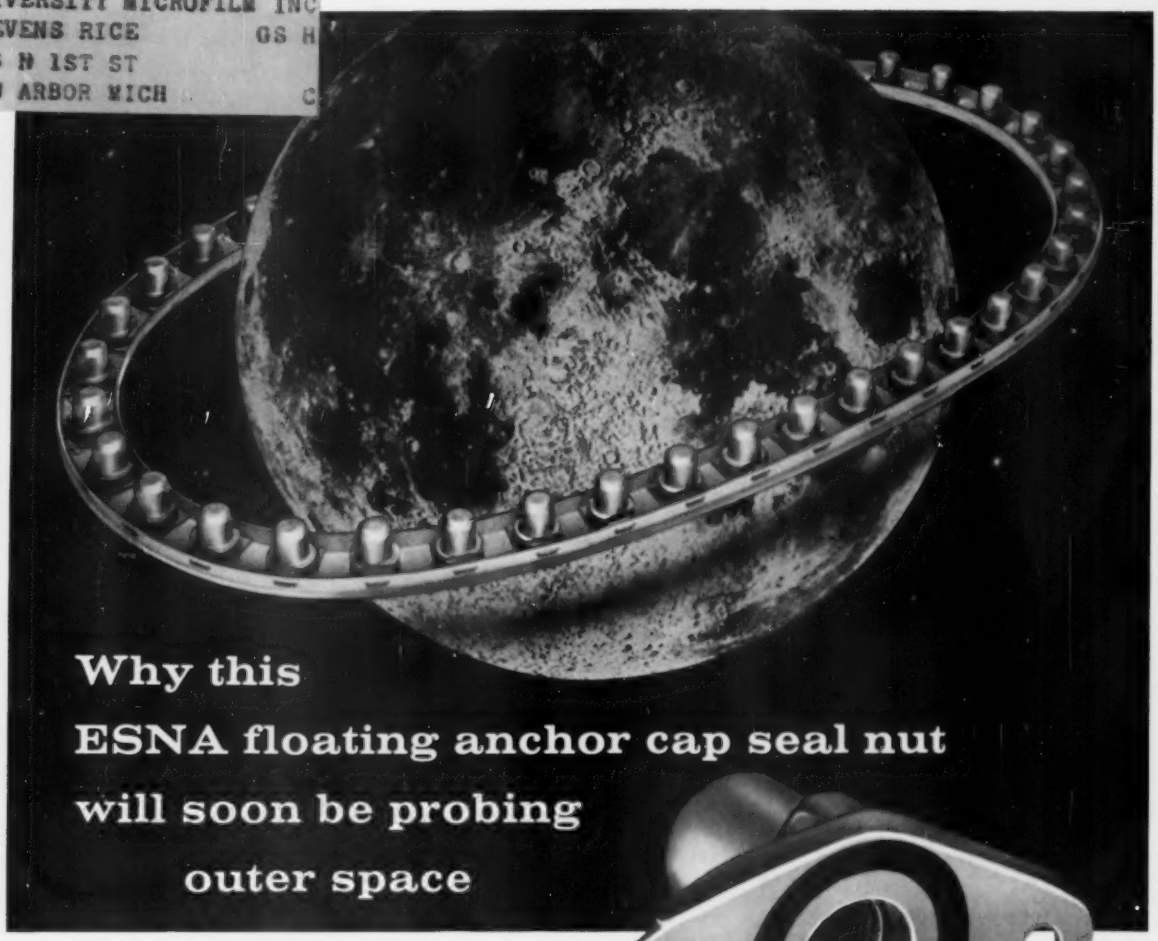


Why this ESNA floating anchor cap seal nut will soon be probing outer space

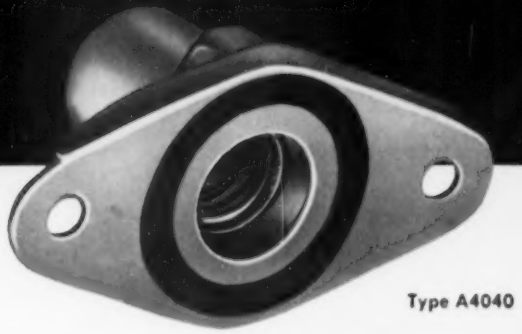
This Type A4040 floating anchor, base seal, capped nut has been selected to go along on the first manned space flights aboard the National Aeronautics & Space Administration's Astronaut capsule. We can't illustrate this special application as yet, but we can tell you about the unusual performance characteristics of this new design.

Type A4040 is a self-locking anchor nut with a special "0"-ring in the base that provides an hermetic seal to prevent loss of air pressure through seepage along the bolt threads. The stop nut held captive inside the dome provides .020 inch minimum radial floating action to allow quick bolt installation in spite of slight misalignment of bolt holes. It is *100% seal tested* before shipment. The seal is effective whether the bolt is installed or not, and is not destroyed by repeated bolt installations. It will withstand vibration and temperature variations from –70° F. to 400° F.

The A4040 is a typical example of ESNA's willingness to work on the special fastener problems faced by engineers who are designing for the space age.

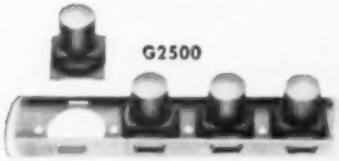
Let us send you complete details on the wide variety of cap seal nuts specifically designed for internal fuel tank fastenings to prevent seepage of volatile fuels: two lug (A2502) and its miniaturized equivalent A2506; one lug (A2507) and straight gang channel strips (G2500). Consider too, the access door design opportunities provided by a football-shaped ring of cap seal nuts such as the one illustrated above and which is performing outstandingly in the integral fuel tanks of one of the nation's newest jet liners.

Write . . . Dept. S54-925, Elastic Stop Nut Corporation, 2330 Vauxhall Road, Union, New Jersey.



Type A4040

A2502 Miniature A2506 A2507



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